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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 4830, 4854, 4960, 5020, 5037–5039, 5043, 5052, 5865, and 6017.

4520 (BARC–338) DETERMINATION OF NICKEL IN ORE SAMPLES FROM JADUGUDA. Swamy, Smt. S. D.; Padmanabhan, P. K.; Venkateswarlu, Ch. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 5p. Dep.

Nickel is separated from other mineral associates using a strong base anion exchanger, Amberlite IRA-410 in 6M hydrochloric acid containing 5 vol % ethanol. It is determined spectrophotometrically by the usual dimethylglyoxime method. (auth)

4521 (IN–1223) A LABORATORY DISSOLUTION AND RADIOCHEMICAL ANALYSIS OF A URANIUM, CALCIUM, AND ZIRCONIUM OXIDE NUCLEAR FUEL. Girton, R. C.; Scott, J. G.; Huff, G. A. (Idaho Nuclear Corp., Idaho Falls). Oct. 1968. Contract AT(10-1)-1230. 13p. Dep. CFSTI.

A method is described for the dissolution of a UO_2–Ca-stabilized ZrO_2 nuclear fuel by a pyrosulfate fusion technique. Certain fission products (^{99}Mo, ^{143}Ce, ^{140}La, ^{140}Ba, and ^{103}Ru) were analyzed by various procedures to determine nuclide concentrations used in burnup calculations. The percent recovery of the nuclides and an explanation of the burnup calculations for up to 100 transients are discussed. (auth)

4522 (LA–3985) SEPARATION AND SPECTROCHEMICAL DETERMINATION OF 0.5 TO 5 ppm NIOBIUM, TANTALUM, AND TITANIUM IN URANIUM. Burnett, H. M.; Pena, J. V.; Martell, C. J.; Phelps, R. T. (Los Alamos Scientific Lab., N. Mex.). May 1968. Contract W-7405-eng-36. 19p. Dep. CFSTI.

Microgram quantities of niobium, tantalum, and titanium are separated from uranium and determined by emission spectrochemical analysis. The elements are extracted into chloroform as complexes of N-benzoylphenylhydroxylamine (BPHA) from a 10N hydrochloric acid solution of the uranium. The chloroform extract is treated first with aqueous iron(II) and then with citric acid to remove vanadium and iron interferences. The organic material is removed by evaporation and ignition; the residue is dissolved in a hydrochloric–hydrofluoric acid mixture. The solution of extracted elements is evaporated on the ends of graphite electrodes, then excited by spark discharge. For samples containing 5.0 grams of uranium, the method covers the concentration range of 0.5 to 5.0 ppM. Standards are processed in the same manner as samples. Hafnium and palladium are added to serve as internal standards. More reliable results are obtained with hafnium because it is carried through the entire procedure, whereas palladium is added after the extraction processing. With hafnium, the precision is 15% relative standard deviation using photographic recording and photometry. Results from spiked samples and a statistical evaluation of synthetic samples are presented to indicate the reliability of the method. (auth)

4523 (NLCO–1025) SUMMARY TECHNICAL REPORT FOR THE PERIOD JULY 1–SEPTEMBER 30, 1968. Burgett, R. (ed.) (National Lead Co. of Ohio, Cincinnati). Nov. 1968. Contract AT(30-1)-1156. 31p. Dep. CFSTI.

Research progress is reported on: colorimetric determination of microgram concentrations of Zr in thorium materials, reduction of machining stock on Mark VR extruded tubing, annealing of a heavily worked uranium-base alloy, high-temperature drop hammer and hardness tests of cast uranium-base dilute quinary alloys, microhardness of a uranium-base alloy compared with high-purity uranium, and continuous determination of NO_2 in plant gas streams. (M.C.G.)

4524 (STI/PUB-155) NUCLEAR ACTIVATION TECHNIQUES IN THE LIFE SCIENCES. Proceedings Series. Proceedings of the Symposium held in Amsterdam, 8–12 May 1967. (International Atomic Energy Agency, Vienna (Austria)). 1967. 720p. (In several Languages). (CONF-670546). IAEA: $14.50; Austrian Schillings 375,–; £ 5.2.4; F Fr 71,10; DM 58,–.

Separate abstracts are presented on 48 of the papers in this symposium. The symposium dealt with the physical and chemical techniques and analytical reference materials used in activation analysis, comparisons of this analytical method with other methods of trace analysis, and techniques and examples of plant, animal, medical, public health and forensic science applications of activation analysis. Each paper, presented in its original language, has an abstract in the original language and in English. Discussions are all in English. An author index is included. (E.R.B.)

For abstracts of individual papers see: 4539–4559, 4561–4581, 5020, 5037–5039, 5043, and 5052.

4525 SPECTROPHOTOMETRIC DETERMINATION OF LANTHANUM WITH CHROMAZUROL S. Horiuchi, Yoshizo; Nishida, Hiroshi (Iwate Univ., Japan). Bunseki Kagaku, 17: 1233–8(Oct. 1968). (In Japanese).

Two milliliters of 0.25% Chromazurol S (CAS) solution was added to 10 to 15 ml of an acidic solution containing La, and pH was adjusted to 6.5 with 7% hexamine solution. After 30 min, the absorbance at 510 mμ was measured against the reagent blank. Beer's law was obeyed for 5 to 140 μg La/25 ml, and the apparent absorptivity at 510 mμ was 1.3×10^4. The interferences from di-, tri-, and tetravalent cations were removed by the separation of La as a fluoride. Lanthanum and Pr or La and Yb were determined simultaneously by measuring the absorbances at 520 and 600 mμ, respectively. The properties of CAS complexes of Pr, Nd, Gd, Dy, Ho, and Yb were also studied. (NSA of Japan)

4526 X-RAY FLUORESCENCE ANALYSIS OF COBALT, TITANIUM, TANTALUM, NIOBIUM, AND IRON IN CEMENTED CARBIDE. Maeda, Ryoichi; Hino, Koichi (Sumitomo Electric Industries, Ltd., Osaka). Bunseki Kagaku, 17: 1239–46(Oct. 1968). (In Japanese).

The rapid and nondestructive determination of Co, Ti, Ta, Nb, and Fe in cemented carbide was investigated by x-ray fluorescence analysis. The powdered carbides were briquetted by pressing in an aluminum ring, and the relations of the fluorescent x-ray intensity to matrix effect, grain size, and the career of samples were studied. The results showed that the x-ray intensity was influenced by the grain size and the career, but not by the matrix effect. Standard samples with a career similar to that of the testing samples were usable for analysis of powdered carbides. For samples with different careers oxidation by burning was found to eliminate the difference. Cemented carbide was studied with regard to the influence of its surface area and its roughness on the intensity of fluorescent x-rays, and the minimum area required for sufficiently sensitive analysis was determined. The proposed method has a reliability comparable to chemical analysis. (NSA of Japan)

4527 SPECTROPHOTOMETRIC DETERMINATION OF MICROAMOUNT OF BORON IN ZIRCONIUM AND ZIRCALOY BY

SOLVENT EXTRACTION. Sudo, Emiko; Ikeda, Sachiko (National Research Inst. for Metals, Tokyo). Bunseki Kagaku, 17: 1197-1203(Oct. 1968). (In Japanese).

The micro-amount of B in Zr and Zircaloy was determined by extraction-spectrophotometry. A sample was dissolved with HF and H_2SO_4 and the solution was allowed to stand at room temperature. Boron was converted to tetrafluoroborate (BF_4^-), and extracted as a colored complex with Methylene Blue in dichloroethane. The organic layer was washed with water. Boron was determined by measuring absorbance of the organic layer at 657 mμ against dichloroethane. The matrices and common constituents in Zr and Zircaloy did not interfere. About 0.2 ppM of B in Zn and Zircaloy could be determined by addition method with variation coefficient about 2%. (NSA of Japan)

4528 MEASUREMENT OF FILM ACCUMULATION IN A TRICKLING FILTER BY NEUTRON MODERATION. Sullins, Jess A. Jr. (North Carolina State Board of Health, Raleigh); Galler, William S. J. Water Pollut. Contr. Fed., 40: R303-15(Aug. 1968).

Putrescible organic material is removed from wastewater passing through a trickling filter by adsorption on a biological film. From measurements of the amount of film present at any given time and a knowledge of film activity or acclimatic conditions, performance of a trickling filter can be predicted. Ultimately, the biota and film thickness could be controlled to provide maximum efficiency for particular waste strengths and climatic conditions. A neutron-moderation technique was developed for measuring the amount of biological film in a trickling filter. Previously, the only method available for measuring the weight or volume of film on the medium in a trickling filter was to scrape the film by hand and to dry and weigh the scrapings. A 5-mCi $^{226}Ra-Be$ neutron source was employed along with a BF_3 slow-neutron detector (enriched with 96% ^{10}B at 200 mm Hg). Details of this portable unit are described, as well as measurements of the amount of film in a particular biological filter under field conditions, at the Walnut Creek Sewage Treatment Plant in Raleigh, N. C. Results of this in situ method of moisture determination using neutron moderation showed the technique to provide a rapid and economic way for determining the amount of volatile matter in a trickling filter. A definite plateau 2.0 to 2.5 ft below the surface of the filter occurred during the winter months in the biological filter examined. It is attributed to a change in the biota with depth. The horizontal distribution over the filter was the same except for random differences. (BBB)

4529 METHOD FOR MEASURING THE CONCENTRATION OF RADIOACTIVE CESIUM IN SEA-WATER. Kadoya, Shozo (to Ebara Mfg. Co., Ltd.). Japanese Patent 1968-12476. May 27, 1968. Filed Nov. 12, 1962.

A method is described for the separation and determination of Cs in seawater. Acidified seawater is brought into contact with ion-exchange particles containing a ferrocyanide metallic salt in the form of $M_AM_BFe(CN)_6$, where M_A is an alkali metal or hydrogen and M_B is a heavy metal such as Fe, Ni, or Co. (NSA of Japan)

4530 A RAPID AND SPECIFIC DETERMINATION OF TRACES OF PLUTONIUM WITH A RECORDING SPECTROPHOTOMETER. Buijs, K.; De Dalmassy, B. Chavane; Maurice, M. J. (EURATOM, Karlsruhe, Ger.). Anal. Chim. Acta, 43: 409-15(1968).

A spectrophotometric method for the determination of plutonium in the range of 0.2 to 140 mg/l is described. The method is based on the measurement of the absorption of plutonium(VI) at 831 nm. A recording spectrophotometer with variable slit width, 10-cm cells and scale expansion facilities, is necessary. Uranium up to 20 g/l does not interfere. (auth)

4531 DIRECT DETERMINATION OF SUBMICROGRAM AMOUNTS OF OSMIUM AND RUTHENIUM IN SULPHIDE ORES BY NEUTRON ACTIVATION ANALYSIS. Chung, K. S.; Beamish, F. E. (Univ. of Toronto). Anal. Chim. Acta, 43: 357-68(1968).

A neutron activation method, involving a radiochemical separation based upon two consecutive distillations, is described for the direct determination of nanogram amounts of osmium and ruthenium in selected sulfide ores. A loss of osmium due to volatilization occurred when the tracer solution was evaporated. A simple radiochemical method using iron(III) hydroxide precipitation was devised to prevent this loss. The proposed method was applied to ores expected to contain only traces of platinum metals. The addition of the active carrier was found to improve the separation of these two metals in the submicrogram range, although, no chemical yield determination was necessary. (auth)

4532 QUANTITATIVE SPECTRAL DETERMINATION OF RARE EARTH ELEMENTS OF THE CERIUM AND YTTRIUM SUBGROUPS IN ORES AND MINERALS. Fadeeva, L. A.; Karpenko, L. I.; Bel'tyukova, S. V. Zavod. Lab., 34: 1066-7(1968). (In Russian).

A spark method for the quantitative spectrographic determination of Ce, La, Pr, Nd, Sm, Eu, Gd, and Y, which is a continuation of a previously developed method for the determination of rare earth elements in solutions of their mixtures isolated from ores or minerals, is described. The sensitivity of the determination in solutions approximates 0.1 to 0.001 mg/ml Ln_2O_3 that corresponds to the following values of the sensitivity of their determination in natural substances: La, Ce, Pr, Nd, Sm, and Gd 0.2%; Eu and Y 0.005 to 0.05%. Standard error for individual determinations is 8 to 10%, respectively. (tr-auth)

4533 ELECTRON PROBE MICRO ANALYSIS OF THIN OXIDE FILMS. Bennett, M. J.; Shaw, J. L.; Chaffey, G. H. (Atomic Energy Research Establishment, Harwell, Eng.). Lab. Pract., 17: 1230-2(Nov. 1968).

A technique is described for the electron probe analysis of oxide films <4 μm thick, which involves the examination of chemically stripped films. The procedure was used to determine the composition of oxide films formed during the oxidation of austenitic stainless steels at elevated temperatures, including the highly irradiated corrosion products of in-reactor oxidation. (auth) (UK)

4534 METHOD OF ASSAYING AND DEVICES FOR THE APPLICATION OF SAID METHOD. Martinelli, Pierre (to Commissariat a l'Energie Atomique). U. S. Patent 3,404,275. Oct. 1, 1968. Priority date Apr. 1, 1963, France.

The heavy elements contained in a sample are determined by exciting a fluorescent K line of the element by γ radiation from a radioactive source, simultaneously determining the intensity I_k of the excited line (quantity of heavy element) and the intensity I_b of the back-scattered Compton radiation (quantity of sample tested), and determining the amount of heavy element from the ratio I_k/I_b. The energy of the γ radiation is several times higher than the energy of the K line of the heavy element. (B.L.M.)

4535 RADIOACTIVATION DETERMINATION OF MICROIMPURITIES IN THALLIUM. Gil'bert, E. N.; Pronin, V. A. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Zh. Anal. Khim., 23: 1747-50(Nov. 1968). (In Russian).

A method is described for the neutron activation determination of 20 microimpurities in thallium, which is based on the extraction separation of the determined impurities. β,β′-dichlorodiethyl ether, dimethylbenzylalkylammonium chloride, and di-n-butyl thiophosphoric acid were used as extracting agents for the separation of thallium and other elements. (auth)

4536 DETERMINATION OF SMALL AMOUNTS OF P IN YTTRIUM AND GADOLINIUM OXIDES OF HIGH PURITY. Kostyukova, E. S.; Raikhbaum, Ya. D.; Volkova, N. F. Zavod. Lab., 34: 1070-2(1968). (In Russian).

A method is described for determining small amounts of P in the oxides of rare earths. Higher sensitivity (0.0005 to 0.001%) was achieved by a low-voltage pulse discharge obtained by additional capacitance in the generator. The determination of contents of 0.001 to 0.1% is characterized by a coefficient of variation of 15 to 20%. (tr-auth)

4537 SQUARE-WAVE POLAROGRAPHIC DETERMINATION OF TRACE OF METALS BY USING CHELATE-SUBSTITUTION REACTION. 4. DETERMINATION OF THORIUM IN ZIRCONIUM OXIDE. Hagiwara, Kazuyoshi (Government Industries Research Inst., Osaka). Osaka Kogyo Gijutsu Shikenjo Kiho, 19: 118-24 (June 1968).

For microdetermination of Th in ZrO_2, the substitution reaction between Pb-EDTA and Th was studied polarographically. Lead was substituted quantitatively by Th within the pH range of 2.9 to 3.7 of the solution. When the pH of the solution was less than 2.9, the Pb-EDTA chelate was remarkably dissociated, and the substitution reaction did not take place quantitatively. On the other hand, Th was hydrolyzed partially at pH values above 3.7. Temperature change within the range of 12 to 30°C had no apparent effect on the substitution reaction. The substitution reaction proceeded quantitatively upon addition of Pb-EDTA solution to the sample solution of pH 3.0 buffered with monochloro-acetate. Linear relationship was found between the concentration and the peak current of Pb over the concentration range from 1×10^{-6} to 7×10^{-6} M of Th. Potassium sulfate did not interfere, but PO_4^{3-} interfered remarkably because of the formation of thorium phosphate complex. Indium, Fe(III), Mo, Zn, Ti, and mixed rare earths which had been purified from xenotime ore interfered, but alkaline earth elements, Al, Mn(II), Cd, Fe(II), Cu, V, Ni, and Co caused no interference. For the present study of the determination of trace amounts of Th in ZrO_2, the TTA-benzene extraction method was applied to the separation of Th from Zr. Zirconium was extracted into organic layer from aqueous 6N HNO_3 solution, but Th remained in the

aqueous layer. The method was applied to the analysis of ZrO_2 containing 0.007% of Th and the result agreed well with that of the spectrographic method studied by other investigators. (NSA of Japan)

4538 EXTRACTION-PHOTOMETRIC DETERMINATION OF URANIUM(VI) AS A COMPLEX COMPOUND WITH THENOYLTRIFLUOROACETONE AND RHODAMINE C. Burtnenko, L. M.; Poluektov, N. S.; Kononenko, L. I. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim., 23: 1647-50(Nov. 1968). (In Russian).

Ions of many elements form complex compounds with thenoyltrifluoroacetone and rhodamine C which can be extracted with benzene. Conditions were found for the extraction of the uranyl ion complex. Its composition corresponds to the formula $[UO_2(TTA)_3]$ BH, where B is a rhodamine C molecule. Optimum conditions for the reaction were found and an extraction-photometric method was developed for determining uranyl ions in a solution of their salt. Ions of foreign metals are masked with complexone III. (auth)

4539 COMPARISON OF NUCLEAR ACTIVATION METHODS FOR BROMINE. INSTRUMENTAL ANALYSES OF PESTICIDES IN PLANT MATERIALS CLOSE TO THE LIMIT OF SENSITIVITY. Wainerdi, R. E.; Menon, M. P. (Texas Agricultural and Mechanical Univ., College Station). pp 33-50 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

The various instrumental and data reduction techniques developed to measure traces of bromine by neutron activation methods, especially those employed in the limit of sensitivity range wherein special statistical methods are necessary, are discussed. A large number of samples of soils, foliage, orange, and vegetable materials, activated in the Texas A&M Research Reactor were counted at appropriate times after activation using three different counting systems: an automated system with an NaI (Tl) spectrometer; a 2 cm^3 Ge(Li) solid-state detector connected to a Victoreen 3200-channel analyzer; and a slow γ-γ coincidence unit. The spectral data from the automated system were reduced by the AA-6 least squares method, and alternatively by means of computer spectrum stripping and peak area computation methods. The photopeak activities from the solid-state detector spectra were measured by the peak area method. The results obtained from the three counting systems using different data reduction techniques were compared to determine the best for the measurement of bromine concentration in the limit-of-sensitivity range. The γ-γ coincidence counting technique appears to have advantages in measuring the bromine content even in the ppM range in samples containing sodium and potassium interferences. The advantages and disadvantages of all the three methods are discussed. (auth)

4540 RAPID DETERMINATION OF MAGNESIUM AND ALUMINIUM IN PLANTS BY ACTIVATION WITH 14-MeV NEUTRONS. Breynat, G.; Fourcy, A.; Garrec, J. P. (CEN, Grenoble, France). pp 81-98 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967. (In French).

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

The Centre d'Études Nucléaires at Grenoble has small electrostatic accelerators that generate fast neutrons of 14-MeV energy. Numerous elements found in plant material can be activated in this flux, mainly by (n,p), (n,α), and (n,2n) reactions, so much so that a single radioelement can be formed from several stable elements with neighboring atomic numbers. The first interference investigated is that caused by magnesium and aluminum at the concentrations found in plants. By activation with 14-MeV neutrons, magnesium forms ^{24}Na by the $^{24}Mg(n,p)^{24}Na$ reaction. Sodium-24 is also formed from aluminum by the $^{27}Al(n,\alpha)^{24}Na$ reaction. However, the influence of the aluminum can be assessed by means of the side-reaction $^{27}Al(n,p)^{27}Mg$. The ^{24}Na and ^{27}Mg activities are measured by γ spectrometry. The method is used for magnesium determination in plants. An initial stage in the research is to make a systematic analysis of magnesium in an aluminum-deficient experimental culture, with or without magnesium deficiency. With a view to generalizing the procedure, current research is directed toward making use of the entire gamma spectrum of activated plant matter. A computer is used to break down the spectrum into six main spectral regions by the least-squares method. As a first approximation, these regions are those obtained from aluminum, calcium, potassium, magnesium, phosphorus, and silicon standards in standard activation and radioactive decay conditions. (auth)

4541 PHOTONUCLEAR ACTIVATION ANALYSIS OF BIOLOGICAL MATERIALS FOR VARIOUS ELEMENTS, INCLUDING FLUORINE. Andersen, G. H.; Graber, F. M.; Guinn, V. P.; Lukens, H. R.; Settle, D. M. (General Dynamics Corp., San Diego, Calif.). pp 99-113 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

Photonuclear activation analysis (PNAA) studies of a number of kinds of biological and nonbiological materials were carried out at these laboratories, in addition to high-flux thermal-neutron and moderate-flux 14-MeV neutron activation analyses of the same materials. The photonuclear studies were carried out with the two high-current electron linear accelerators with 17 MeV and 45 MeV maximum energies. These accelerators were operated at electron energies from 2 MeV up to the maximum, and at integrated beam currents up to 0.5 mA. The partially diffused electron beam was absorbed in a water-cooled tungsten converter, to produce an intense bremsstrahlung beam. Samples were irradiated in a pneumatic tube just in front of the converter, or in a spinning multisample tack just beyond the pneumatic tube. Some of the advantages of high-flux PNAA, as compared with a high-flux thermal-neutron activation analysis, in certain instances are: some elements, such as C, N, and O, can be determined more sensitively, the ^{24}Na interference encountered in the thermal-neutron activation of many biological samples is eliminated, many interfering activities can be eliminated by adjustment of the electron energy to values below the thresholds of interfering reactions, alternate products, in some cases of more convenient half-lives or γ energies than those produced by (n,γ) reactions, can be formed, and the problem of self-shielding is eliminated. The high penetrability of the bremsstrahlung photons makes the method more generally useful than charged-particle activation analysis. The experimentally determined limits of detection of some 40 elements studied, mostly by the (γ,γ') and (γ,n) reactions, are reported, as well as photonuclear results on samples of hair, blood, urine, whisky, wood, tobacco, and green plants. Detailed studies of the determination of fluorine in biological samples, by the $^{19}F(\gamma,n)^{18}F$ reaction, are described, and the results compared with fluorine determinations in the TRIGA reactor, by the $^{19}F(n,\gamma)^{20}F$ reaction (both steady-state and pulsed), and with a 14-MeV neutron generator, by three different fast-neutron reactions. (auth)

4542 RADIOCHEMICAL SEPARATIONS IN ACTIVATION ANALYSIS OF BIOLOGICAL SPECIMENS. Survey Paper. Girardi, F. (CCR-EURATOM, Ispra, Italy). pp 117-35 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

The different techniques of radiochemical separation are reviewed, and the problems associated with their use for biological specimens are considered. Modern trends are discussed, particularly those resulting from the availability of more selective detectors and the application of computer techniques to data handling. The automation of radiochemical separations is discussed. (auth)

4543 CHROMATOGRAPHIC GROUP SEPARATION SCHEME USED WITH GAMMA SPECTROMETRY FOR MULTI-ELEMENT ACTIVATION ANALYSIS SURVEYS. Jervis, R. E.; Wong, K. Y. (Univ. of Toronto). pp 137-58 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

A comprehensive multi-element trace analysis survey of biological samples can be accomplished by applying high-flux neutron activation in conjunction with radiochemical separation procedures and γ spectrometry. A sequential ion-exchange group-separation scheme was developed for that purpose from a knowledge of basic ion-exchange behavior of the elements in different media, and was applied in an activation analysis survey of more than ten detectable trace elements in human whole blood. The scheme involved three small anion and cation exchange columns on which a solubilized irradiated sample of biological material was applied without the addition of carriers and subsequently was eluted into 10 to 15 groups of several ml each containing nuclides of two to five elements. Some components were adsorbed from concentrated HCl solution onto Dowex 1 anion exchanger and chromatographically eluted with HCl and HCl-HF solutions of decreasing concentrations. The nuclides not adsorbed initially by the first column were taken up, after evaporation, onto Dowex 50 cation exchanger from

citrate buffer and eluted with various citrate, KSCN and EDTA solutions. A third column, of Dowex 1, served to further separate the alkali elements from the KSCN group. Most of the groups contained both short-lived and long-lived nuclides and, with very few exceptions, the prominent γ rays emitted by nuclides in each group did not overlap in energy. Thus, the several groups were suitable for final detailed analysis by γ spectrometry. The total time required for the radiochemical group separations was 3 to 8 hr. Recovery of nuclides from complex mixtures was shown to be quantitative and in a single group except for Cr (yield from 70 to 100%), W (30 to 100%), and As and Sb that tended to elute in adjacent groups rather than a single group. The procedures as developed were particularly suited to neutron-irradiated biological materials since nuclides of both Na and P produced in large intensities on irradiation, were cleanly separated into single groups with few other constituents. By applying the group separation scheme to a typical sample of irradiated blood it was possible to detect and analyze quantitatively the pp10^9 to ppM contents of Cu, P, Na, Mn, Fe, Zn, Co, Rb, Ca, Ni, Au, and Sb and to establish reliable upper limits for the concentrations of other trace elements, some of which were reported previously in other work. Most analyses were performed with a 3 in. × 3 in. NaI scintillation detector but some instrumental activation analyses of blood were carried out with a high-resolution germanium (Li-drifted) solid-state detector of 22 cm^3 volume making possible a comparison of the two systems for the analysis of biological material. (auth)

4544 SEPARATION SCHEME FOR THE DETERMINATION OF NINE ELEMENTS IN BIOLOGICAL MATERIAL. van den Winkel, P.; Speecke, A.; Hoste, J. J. (Ghent Univ.). pp 159-72 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

A separation scheme is presented for the determination of nine trace elements in biological samples that give rise to long-lived gamma-emitting isotopes by neutron irradiation, namely Ag, Mo, Hg, Au, Cr, Co, Se, Fe, and Zn. The organic material is destroyed by combustion with oxygen in a flask according to Schöniger in the presence of 100 μg of carrier of each element. The ignition is electrical and provides an easy and safe method for burning the samples and avoiding losses of volatile elements. The combustion products are collected in $HNO_3-H_2O_2$ solution. Carrier yields of at least 98% were obtained in tracer experiments, except for gold and silver. At high temperatures these elements apparently form an Au–Pt and Ag–Pt alloy with the platinum combustion catalyst. Boiling the platinum sample holder with a few millilitres of aqua regia results in a quantitative recovery of both elements. The $HNO_3-H_2O_2$ solution is evaporated to dryness and redissolved in 2N HF. A number of trace elements are adsorbed on a Dowex 1-X8 column and eluted successively with 9N HCl, 1.2N HCl, 8N HNO_3 + 4N NH_4NO_3 and 10% thiourea. A quantitative separation is thus obtained of Ag, Mo, Hg, and Au. Cr, Co, Se, Fe, and Zn are not absorbed in 2N HF. This eluate is adsorbed on a second Dowex 1-X8 column in 10N HCl and eluated successively with 10N HCl, 3N HCl, 0.4N HCl and H_2O. Fractions of Cr, Co + Se, Fe, and Zn are obtained. A quantitative separation of Co from Se can be achieved on Dowex 50W-X4 in HCl. The volumes in which the individual elements are quantitatively collected are smaller than 30 ml. Consequently a relatively high counting efficiency can be achieved in a 25-ml well-type crystal. Quantitative recovery for all elements is obtained except for Hg and Au. Mercury losses occur on evaporating the $HNO_3-H_2O_2$ mixture. As a suitable method for the determination of the Hg yield, dithizone titration was chosen. The yield of Au is constant at 90 to 95% and is not determined by chemical means. The method was used to determine the above-mentioned trace elements in kale powder. (auth)

4545 A NEW SODIUM SEPARATION METHOD FOR ACTIVATION ANALYSIS OF BIOLOGICAL MATERIAL. Bock-Werthmann, W. (Gesellschaft fuer Strahlenforschung mbH, Neuherberg, Ger.). pp 173-8 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

For several reasons the Na content of biological materials, seawater, foods, etc., causes trouble in neutron activation analysis. In most of these materials the greatest proportion of the radioactivity after neutron irradiation is usually due to Na. In many cases a variation of the irradiation and decay time does not permit a differentiation from other nuclides owing to the unfavorable half-life. The high energy of its γ radiation disturbs the γ spectra of other elements. The chemical precipitation methods commonly used for removal of Na are far from perfect. The uranylacetate method, used most, does not give a very high yield and adds interfering uranium activity to the analytical solution. A new organic reagent (5-benzamido-9,10-dihydro-9,10-dioxo-2-anthracenesulfonic acid) does not possess these disadvantages. It is completely inactive and for this reason does not disturb the activation analysis if an excess is present in the sample solution after activation. The chemical yield of the separation is good because of the low solubility of the sodium salt formed by the reagent. The amounts of the other alkaline elements that remain in solution are higher because of the higher solubilities of their salts. Adsorption and co-precipitation effects of a number of important elements together with the precipitation of Na were also investigated. The optimal precipitation conditions (temperature, alcohol content, etc.) were determined and the experimental procedures established. They permit the reduction of the Na content either before or after irradiation. This precipitation method is also suitable for the determination of the Na content of biological material by activation analysis. In this case the method should lead to a radiochemically pure product. The method of synthesis of the organic compound is described. (auth)

4546 IMPROVEMENT OF ACCURACY BY MULTIPLE CARRIER ADDITION FOLLOWED BY RE-IRRADIATION YIELD DETERMINATION IN A SIMPLE METHOD FOR THE DETERMINATION OF ARSENIC IN BIOLOGICAL MATERIAL. Heydorn, K. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). pp 179-88 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

Neutron activation analysis for the determination of arsenic in biological material ususally requires a post-irradiation radiochemical separation providing very high decontamination factors, particularly for such elements as Sb and Cu, that might give rise to serious inaccuracy in the measurement of ^{76}As with an NaI(Tl) scintillation detector by multichannel gamma spectroscopy. It is shown that the addition of carrier to interfering elements as well as to the element to be determined, in the same ratio as they are expected to occur in the sample material, will result in an overall improvement in accuracy, provided that chemical yield is determined by re-irradiation. Based on this concept, a new method for the radiochemical determination of arsenic in biological material was developed. Apart from dissolution of the sample, the method involves only precipitation with a mixture of iodide-ascorbic acid and cupferron, followed by precipitation with thioacetamide, and yields a precision and accuracy of less than 0.01 ppM, which is more than sufficient for a variety of biological samples. The principle of multiple carrier addition followed by re-irradiation yield determination gives rise to an overall gain in accuracy, regardless of the radiochemical separation method employed. (auth)

4547 SUBSTOICHIOMETRIC DETERMINATION OF TRACES OF THALLIUM AND PLATINUM BY ACTIVATION ANALYSIS. Adamek, A. (Inst. of Physics, Bratislava); Obrusnik, I.; Kukula, F.; Krivanek, M. pp 189-94 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

New, simple, and quick radiochemical methods were developed for the substoichiometric separation of thallium and platinum. The method for thallium is based on replacement of thallium from thallous dithizonate (in organic-phase $CHCl_3$) by a substoichiometric amount of the aqueous solution of mercury (II). Preliminary steps are the extraction of thallium from 5N sodium hydroxide solution (10% potassium cyanide) with a small excess of chloroform solution of dithizone and the washing of the extract with 5N aqueous ammonia. The time necessary for the separation is 3 to 4 min. After the separation, the activity of radiothallium is measured. The proposed method can be used for the determination of traces of thallium in all sorts of matrices without interference from foreign elements (only large amounts of lead can interfere). Platinum may be separated in the following way: interfering metals are removed by preliminary extraction from a weak acid solution of the sample, in which platinum is in the quadrivalent state, by using a chloroform solution of the diethylammonium salt of diethyldithiocarbamate. After reducing the platinum to the divalent state and adjusting the sample solution to 1M in hydrochloric acid, platinum is extracted by a substoichiometric amount of cupric diethyldithiocarbamate in $CHCl_3$. After washing the extract, the activity of radioplatinum is measured. With the proposed procedures, thallium and platinum may be determined by using both short- (^{206}Tl, ^{199}Pt with half-lives 4.2 and 30 min) and long-lived radioisotopes (^{204}Tl, ^{197}Pt with half-lives 3.9 yr and 19 h), because

the procedures are very quick. The procedures were used for the determination of traces of thallium in milk powder and platinum in fish and tea. (auth)

4548 PREPARATION OF AN NBS BIOLOGICAL STANDARD REFERENCE MATERIAL FOR TRACE ELEMENTAL ANALYSIS. Smith, G. W.; Becker, D. A. (National Bureau of Standards, Washington, D. C.). pp 197-207 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

A survey of leading US biological, medical, and forensic laboratories confirms the need for well characterized botanical, soft mammalian tissue, bone tissue, and blood standards with elemental constituents at the 100 ppM level and below. Before reliable analytical data can be obtained the reference material must be considered homogeneous and tests for inhomogeneity should be performed. Examples are given of this procedure, which is carried out routinely by the NBS on Standard Reference Materials. Homogeneity of Bowen's kale for chlorine (~4000 ppM), manganese (~14 ppM), and copper (~6 ppM) as well as for manganese in beef liver (~10 ppm) citrus leaf (~28 ppM), and oak leaf (~1000 ppM) are given. Measurements were made by neutron activation analysis both with and without chemical separation, using a Ge(Li) semiconductor detector. This technique was also used for the quantitative determination of the trace constituents chlorine and manganese, nondestructively. In addition, a destructive method was used for the elements arsenic and copper. Analyses of variance, using the activation analysis data, show for all of the biological materials except the citrus leaves no evidence of inhomogeneity. Therefore, preparation under contract, of large lots of deciduous leaves and beef liver, will begin. Tests for inhomogeneity and elemental content certification will be made by NBS activation analysis and other analytical methods. (auth)

4549 TRACE ANALYSIS OF BIOLOGICAL MATERIALS BY MASS SPECTROMETRY AND ISOTOPE DILUTION. Survey Paper. Morrison, G. H. (Cornell Univ., Ithaca, N. Y.). pp 211-28 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

Mass spectrometry and its application to biological problems are discussed. Although mass spectrometry is capable of providing information on both the elemental and molecular composition of biological materials, only the former is treated here. Among the methods of excitation for elemental analysis reviewed are vacuum spark, electron bombardment, thermal ionization, and ion bombardment. Because of its many advantages, particular emphasis is placed on the role of spark-source mass spectrometry in the determination of trace elements in animal tissue, body fluid, and plant material. The isotope dilution technique, which is essentially an internal standard method involving stable isotopes, provides mass spectrometry with some of its most sensitive and precise methods of elemental analysis, with reproducibilities on the order of ±0.1%. Its application to biological problems is discussed. Finally, the advantages and limitations of mass spectrometry are compared with those of activation analysis. (auth)

4550 ELEMENTAL ANALYSIS OF A BIOLOGICAL STANDARD REFERENCE MATERIAL BY NONDESTRUCTIVE METHODS; COMPARISON BETWEEN RADIOACTIVATION ANALYSIS AND X-RAY FLUORESCENCE SPECTROSCOPY. Girardi, F.; Pauly, J.; Sabbioni, E.; Vos, G. (CCR-EURATOM, Ispra, Italy). pp 229-46 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

A biological product, available as a standard reference material for laboratory intercomparison, was analyzed nondestructively by two techniques; neutron activation analysis and x-ray fluorescence spectroscopy. The results obtained are presented and discussed. Eighteen elements were determined by activation analysis and thirteen by x-ray fluorescence spectroscopy. The results obtained for elements determined with both techniques generally agreed within the experimental errors. Higher sensitivity, better precision, and lower matrix effects are advantages of activation analysis, while the long time necessary for complete instrumental analysis is the main drawback. X-ray fluorescence spectroscopy is characterized by a shorter analytical time, but also by a lower precision and sensitivity. Matrix effects can be important in this case, especially for the light elements, but some of them can be corrected to a certain extent by calculations. (auth)

4551 ATOMIC ABSORPTION AND FLAME EMISSION SPECTROMETRY IN TRACE ANALYSIS OF BIOLOGICAL MATERIALS. Survey Paper. Herrmann, R.; Lang, W. (Univ., Giessen, Ger.). pp 247-65 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

The principles of atomic emission, atomic absorption, and atomic fluorescence analysis in flames are described. A comparison is also given of the advantages and disadvantages of flame photometric emission and absorption analysis relative to neutron activation analysis. The comparison is made on the basis of the cost of equipment, local requirements, personnel qualifications, the time required for and the cost of each analysis, specificity, detection limits, and precision and accuracy. Characteristic differences between flame photometry and neutron activation analysis are emphasized, and it is shown that neither method is generally superior or preferable; in fact the methods are often complementary. In practice, the choice of which method to use differs from case to case, and depends on the nature of the particular problem under investigation. (auth)

4552 DETERMINATION OF STABLE STRONTIUM IN BIOLOGICAL SAMPLES BY ATOMIC ABSORPTION, FLAME SPECTROPHOTOMETRY, AND ACTIVATION ANALYSIS METHODS. van Puymbroeck, S.; Jacquemin, R.; Colard, J.; Kirchmann, R.; van der Borght, O. (CEN, Mol, Belgium). pp 267-84 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967. (In French).

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

The procedure for determining stable strontium in biological samples is described. In atomic absorption and flame spectrophotometry chemical separation is performed from the ashed residues of the sample; calcium and strontium are obtained in the oxalate form. This separation is necessary owing to the presence of phosphate and other interfering ions in the ashed residue. Another way of eliminating interfering ions is to pass the solutions obtained by dissolving the ashed residues over resins. Determination by flame spectrophotometry necessitates prior determination of the calcium in order to adapt the standard solutions to the calcium concentrations. With the atomic absorption method, high calcium concentrations have no effect on the strontium determination. In neutron activation analysis the ashed residues of the sample are exposed to an integrated neutron flux of approximately 10^{15} n/cm^2; the strontium is then isolated by chemical separation. The decontamination coefficients vary between 10^6 and 10^3 depending on the nature of the interfering element. The strontium sulfate precipitate is measured by γ spectrometry of the 388-keV peak of ^{87}Sr. The measurements are calibrated by irradiating strontium nitrate solutions of known standard strength under the same conditions. The chemical separation yield is determined by adding an ^{85}Sr tracer to the sample. The results obtained together with the advantages and disadvantages of the three methods, are compared and discussed. (auth)

4553 ACTIVATION ANALYSIS IN BOTANY AND AGRICULTURE. Survey Paper. Bowen, H. J. M. (Univ. of Reading, Eng.). pp 287-99 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

Applications of activation analysis to the plant sciences are reviewed. It offers a practical method of measuring the concentrations of trace elements such as Co, Cu, Mn, Mo, Se, and Zn in soil solutions. It can also be used to determine phosphorus in soil solutions from phosphate-deficient soils, which cannot be done by current methods. In pure botany there were many applications, mostly concerned with the behavior of essential trace elements. The sensitivity of the method was adequate for analysis not only of minute seeds but of embryos, endosperm, and seed coats dissected from those seeds. Important developments included use of the (n,α) reaction to determine boron, the (p,n) reaction to determine ^{18}O in products of photosynthesis, and the detection of minute traces of organic phosphates on chromatograms. Most papers referred to seed plants, but there was some work on fungi and about 20 elements were determined in algae. Some of the latter elements could not be determined by any other technique. There were numerous applications in agriculture, though here the sensitivity of the method for essential trace elements was not taken advantage of as much as might be expected. There was, however, particular interest in the determination of selenium, mainly because of the difficulty of using conventional analysis for the levels normally found

in herbage and fertilizers. The determination of toxic residues, containing such elements as As, Br, Cl, Hg, or Ni was another application of great potential interest. In a recent intercomparison program involving the analysis of standard kale, activation analysis gave results agreeing with those obtained by other techniques in all but one instance. The exception is the determination of potassium in plant tissue by γ spectrometry. (auth)

4554 IDENTIFICATION AND DETERMINATION OF TRACE ELEMENTS IN RICE SEEDS BY NEUTRON ACTIVATION ANALYSIS. Travesi, A.; Lee, Y. Y. (Junta de Energia Nuclear, Madrid). pp 301-24 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967. (In Spanish).

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

In rice seeds, the high activities of ^{42}K, ^{38}Cl, and other radioisotopes induced by neutron irradiation make it impossible to identify most of the trace elements directly by γ spectrometry. To overcome this difficulty, fast and selective radiochemical group-separation methods were developed that allowed the identification of trace elements such as Ba, Sr, As, Sb, Fe, Cu, Zn, and Cd. Neutron activation analysis was used to determine six elements existing in quantities of the order of milligrams or traces. In these cases, after addition of appropriate carrier elements, the radioisotopes were separated individually by standard radiochemical procedures, and chemical yields were determined. The experimental procedures are described. Among the seeds analyzed, four varieties, Spanish and Korean, were included that were selected by the Institutes of Agricultural Research of Spain and Korea, and were of known origin. Wide differences in trace element concentrations were observed. Measurements on whole seeds and seeds without cortex showed that the trace element contents of the former are two or three times those of the latter. This suggests an enrichment of trace elements in the seed cortex. The concentration ranges observed were: 6 to 50 ppM for Mn, 1 to 4 ppM for Cu, 7 to 45 ppM for Na, 0.2 to 1 ppM for Br, 1000 to 4800 ppM for K, and 200 to 2500 ppM for Cl. (auth)

4555 NEUTRON ACTIVATION ANALYSIS OF VANADIUM, COPPER, ZINC, BROMINE, AND IODINE IN PYURA MICROCOSMUS. Papadopoulou, Catherine P.; Cazianis, C. T.; Grimanis, A. P. (Democritus Nuclear Research Centre, Athens). pp 365-77 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

The simple and rapid determination by activation analysis of vanadium, copper, zinc, bromine, and iodine in Pyura microcosmus, a species of the Pyuridae family, is described. The same elements were also investigated in the environmental seawater. Samples of P. microcosmus and seawater were collected from a point about 15 m below the surface in the Saronic Gulf near Athens. All irradiations of samples and standards were carried out with the DEMOCRITUS Reactor of the Nuclear Research Centre of Greece, at a neutron flux of 2×10^{11} n/cm^2. The time of irradiation with the pneumatic transfer system ranged from 1 to 25 min, depending on the element being determined. After irradiation and addition of inactive carriers, the radioisotopes of interest were isolated by fast radiochemical procedures based on solvent extraction techniques. Vanadium and copper were extracted as cupferrates into chloroform, and zinc was extracted with 8% methyldioctylamine into trichloroethylene. Bromine and iodine were distilled first and then separated from each other by selective redox and extraction procedures. The photopeak areas of ^{52}V, ^{64}Cu, ^{69m}Zn, ^{82}Br, and ^{128}I were measured by means of a multichannel analyzer and compared with those of standards of the above radionuclides processed in the same manner. After irradiation the time to complete the analysis ranged from 5 to 35 min depending on the element being determined. The quantities of the elements determined in P. microcosmus, expressed in micrograms per gram of dry matter, were: vanadium 1.0, copper 7.5, iodine 14.1, bromine 406, and zinc 702. The per cent concentration of the same elements found in the seawater was as follows: vanadium 3.8×10^{-8}, copper 8×10^{-7}, zinc 3.5×10^{-6}, iodine 6.5×10^{-6}, and bromine 4.1×10^{-4}. From the data given it seems that P. microcosmus is another species of the Pyuridae family with low accumulation of vanadium. (auth)

4556 MANGANESE DETERMINATION AT THE pp10^9 LEVEL IN DAIRY PRODUCTS. Das, H. A. (Reactor Centrum Nederland, Petten, Netherlands); van Raaphorst, J. G.; Menger, J. W.; Galesloot, Th. E. pp 379-87 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

By means of the addition of a small amount of manganese the seasonal variation in the flavor of the butter can be eliminated. Manganese stimulates the development of B. cremoris in milk at springtime, and it is quite possible that differences in available manganese are the cause of the differences in development of B. cremoris in the starter culture. The determination of manganese by activation analysis in a large number of samples is described. Milk samples were different in origin, time of year, etc., and marked differences were observed in the amounts of manganese present throughout the year. (auth)

4557 NUCLEAR ACTIVATION IN THE ANIMAL SCIENCES. Survey Paper. Spronk, N. (Free Univ., Amsterdam). pp 335-52 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

Nuclear activation analysis of animal materials was performed as early as 1946. The materials studied were generally related in some way to human life (e.g., meat, blood, and excreta) and were frequently of experimental origin (e.g., mouse, rat, rabbit, or chicken). Major constituents as well as trace elements were studied, usually after activation with thermal (reactor) neutrons. Before 1962 only incidental work for biological research was performed. From then on a substantial increase can be noted in zoological research. The applications of nuclear activation are found in: descriptive studies; distribution of elements and experimental studies; dynamics and interaction of major and minor constituents, mineral metabolic cycle studies, radioecological studies, and toxicological studies. Illustrative results in each of these sections are described. A few specific technical problems such as sampling, standardization, and analysis are discussed briefly, and some of the possibilities for future research are outlined. (auth)

4558 ACTIVATION ANALYSIS OF BIOLOGICAL TISSUE WITHOUT CHEMICAL SEPARATION. Cooper, R. D.; Linekin, D. M.; Brownell, G. L. (Massachusetts Inst. of Tech., Cambridge). pp 65-80 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

Activation analysis studies of blood and tumor tissue samples were made using both neutrons and 25-MeV bremsstrahlung for activation and a large Ge(Li) detector for γ measurements. The combination of the high resolution of the detector and the two methods of activation allowed the measurement of over 20 different elements without the necessity for making any chemical separations. Immediately after activation with thermal neutrons the principal element seen with a γ detector was Na. The Ge(Li) detector allowed measurement of K, Cu, and Mn photopeaks that were visible through the ^{24}Na spectrum. After a decay time of 10 to 12 days, the Na and other short-lived isotopes had disappeared, leaving Sn, Hg, Cr, Cd, Au, Sb, Br, Ag, Rb, Fe, Zn, and Co. The amounts of each of these elements were determined directly from the photopeaks measured with the Ge(Li) detector. There were a number of elements that were either not made radioactive by thermal neutrons or had short half-lives and could not be measured through the large ^{24}Na background. In an attempt to detect these elements, and to prevent the production of ^{24}Na, 25-MeV bremsstrahlung from an electron linear accelerator was used for producing the activity. Immediately after irradiation, the carbon, nitrogen, and oxygen in the sample was measured by determining the decay rate of the positron annihilation gammas. After about two hours, all the ^{11}C had decayed out and other elements such as I, Mg, and Ba could be measured. Typical gamma spectra of biological samples are shown and sensitivities for measuring the different elements are discussed. (auth)

4559 PHYSICAL TECHNIQUES OF ACTIVATION ANALYSIS. Survey Paper. Lyon, W. S. (Oak Ridge National Lab., Tenn.). pp 13-32 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

A number of solely physical methods are used in activation analysis. These include such non-neutron techniques as gamma photon activation, ^3He activation, and charged particle activation and charged particle scattering. In some instances gamma rays or particles emitted either during the reaction or immediately after by the excited nucleus formed are measured. In other cases,

the radiations from decay of the induced radioactive species are measured. Neutron activations using 14-meV neutron generators or fast neutrons from a reactor are less conventional and of considerable less application than thermal neutron activation. All the above techniques are useful primarily for low-Z elements that cannot be easily determined by other methods, and their application is quite limited due to interferences and sample handling problems. Gamma spectrometry is almost invariably used in nondestructive activation analysis. NaI(Tl) spectrometry provides high sensitivity but rather poor resolution. Ge(Li) spectrometry requires considerably more sophisticated equipment and knowledge, but has extremely high resolution, thus making possible many simultaneous determinations. The small size of Ge detectors has limited their efficiency and sensitivity, but as larger size (40 cm^3 and greater) detectors become more available, use of Ge(Li) spectrometry should contribute greatly to improving the quality of non-destructive activation analysis. (auth)

4560 SPECIES FORMED IN THE POTENTIOMETRIC TITRATION OF FLUORIDE WITH THORIUM OR LANTHANUM NITRATE AND FUNCTIONS SUITABLE FOR THE EVALUATION OF THE EQUIVALENCE POINTS. Anfaelt, Torbjorn; Dyrssen, David; Jagner, Daniel (Univ. of Goteborg). Anal. Chim. Acta, 43: 487-99(1968).

Calculations by means of Sillén's HALTAFALL program were performed on experimental curves by Lingane for the potentiometric titration of fluoride with thorium and lanthanum in different media. After adjusting the stability constants for some of the main species formed during the titration a good fit was obtained between the experimental data and the calculated titration curves. In the cases where the solution was buffered with acetate it was necessary to consider the formation of mixed fluoride-acetate complexes. Suitable functions for the evaluation of the equivalence point could be derived from the calculations. If the functions: $F_1 = (v_0 + v)[F^-]$ and $F_3 = (v_0 + v)[F^-]^{-3}$ are used before and after the equivalence point, respectively, it ought to be possible to determine fluoride very accurately by titration with lanthanum nitrate in an unbuffered solution. A value proportional to $[F^-]$ is obtained from 10 exp (– EF/RT ln 10), the Nernst EMF equation. (auth)

4561 DETERMINATION OF PROTEIN-BOUND IODINE BY ACTIVATION ANALYSIS. Tang, C. W.; Tomlinson, R. H. (McMaster Univ., Hamilton, Ont.). pp 427-34 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB–155; CONF-670546.

A simple procedure for determination of protein-bound iodine in blood by reactor activation analysis was developed. The high-energy resolution obtained with the lithium-drifted germanium detector made it possible to measure submicrogram quantities of iodine in the presence of the other trace elements. The procedure is based on the use of an internal standard of added strontium. This involves a comparison of the 390-keV photopeak of 2.8-hr ^{87}Sr and the 440-keV photopeak of the 25-min ^{128}I. Activation analysis appears as an active alternative to the chemical assay procedure where neutron fluxes of the order of 10^{13} n cm^{-2} sec^{-1} are available. (auth)

4562 MEASUREMENT OF STRONTIUM AND BARIUM IN SMALL VOLUMES OF PLASMA BY ACTIVATION ANALYSIS AND SUBSEQUENT ESTIMATES OF THE DIURNAL VARIATION OF THESE ELEMENTS IN HUMAN PLASMA. Carr, T. E. F.; Sutton, Alice (Medical Research Council, Harwell, Eng.). pp 445-54 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB–155; CONF-670546.

A method employing neutron activation analysis is given for the simultaneous measurement of submicrogram quantities (approx. 20 ng) of strontium and barium in biological samples. Neutron activation of the samples is followed by chemical separation and γ spectrometry. Measurements from small volumes of plasma (0.5×1.0 cm^3) permitted repeated sampling of human plasma during a 24-hr period. Though different individuals had plasma strontium levels in the range 2.0 to 4.0 $\mu g/100$ cm^3, the diurnal variations were found to be less than ±5% of the mean on a normal diet. It is well known that the level of calcium in normal human plasma is closely controlled, but other work has shown that this control does not apply to strontium. Since the diurnal variation of the level of strontium in plasma is small, the implications of this are discussed. Simultaneous measurements of barium are given but are less reliable; the mean values and diurnal variation are probably over-estimates. Contamination appears to be the chief cause and is difficult to avoid. Various methods of overcoming this problem are discussed. (auth)

4563 TRACE ELEMENTS IN HUMAN TOOTH ENAMEL. Nixon, G. S. (Univ. of Manchester, Eng.); Smith, H.; Livingston, H. D. pp 455-62 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB–155; CONF-670546.

Estimations of trace elements were undertaken in sound human teeth. By means of activation analysis it was possible to determine trace element concentrations in different layers of enamel in the same tooth. The concentrations of the following elements were determined: arsenic, antimony, copper, zinc, manganese, mercury, molybdenum, and vanadium. The distribution of trace elements in enamel varies from those with a narrow range, such as manganese, to those with a broad range, such as antimony. The elements present in the broad range are considered to be nonessential and their presence is thought to result from a chance incorporation into the enamel. Those in the narrow range appear to be essential trace elements and are present in amounts that do not vary unduly from other body tissues. Only manganese and zinc were found in higher concentrations in the surface layer of enamel compared with the inner layers. The importance of the concentration of trace elements on this surface layer of enamel is emphasized as this layer is the site of the first attack by the carious process. (auth)

4564 DISTRIBUTION OF CARBON, CALCIUM, AND PHOSPHORUS IN DENTAL ENAMEL STUDIED BY CHARGED-PARTICLE ACTIVATION ANALYSIS. Stubbins, Mary; Fremlin, J. H. (Univ. of Birmingham, Eng.). pp 463-78 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB–155; CONF-670546.

Sections of sound human dental enamel embedded in a matrix of sulphur were bombarded by deuterons at 2.2 MeV. Nitrogen-13 is produced from carbon by the reaction $^{12}C(d,n)^{13}N$, and ^{32}P from phosphorus by the reaction $^{31}P(d,p)^{32}P$. Exposure to a process plate for 40 min starting 4 min after bombardment gives an autoradiograph due almost entirely to ^{13}N, whereas a photographic plate exposed for eight days, starting five days after irradiation, gives one due entirely to ^{32}P. Similar autoradiographs were obtained from ^{43}Sc or ^{44}Sc produced by bombardment of tooth sections with protons. During each bombardment, control samples with known contents of carbon, calcium, or phosphorus were also bombarded for calibration purposes. The autoradiographs were examined with the help of a recording microdensitometer with an effective slit of 1.5 mm × 0.08 mm. Errors arising from various sources limit the accuracy of the method to about 10%. The sensitivity for carbon is such that within an area of about 0.1 mm^2 a few tenths of a nanogram can be detected. It was found that the total carbon content of enamel varies from 1.01 ± 0.04% to 1.58 ± 0.05% for molars, and 0.92 ± 0.04% to 1.38 ± 0.05% for premolars, for values at the outer surface and the amelodentinal junction, respectively. This variation is roughly linear. The concentration gradients for calcium and phosphorus are much smaller and may be little larger than the probable errors. (auth)

4565 ELECTROLYTE BALANCE OF THE INNER EAR INVESTIGATED BY NEUTRON ACTIVATION ANALYSIS OF THE SODIUM AND POTASSIUM CONTENT. Oerdoegh, Mary; Miriszlai, E. (Medical Univ. of Budapest). pp 479-89 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB–155; CONF-670546.

Comparative studies were made on sodium and potassium concentrations in the inner-ear fluids, the liquor cerebrospinalis, and mammalian and human serum. The experimental material was obtained from guinea pigs by penetration through the round window (fenestra rotunda). The sodium and potassium content was determined by neutron activation analysis. Potassium was precipitated from the irradiated samples by sodium tetraphenyl borate reagent, so that the sodium activity retained by the filtrate could be directly counted. Since a single precipitation of potassium did not yield end products free from sodium contamination, the precipitate was dissolved in acetone and precipitated again with sodium tetraphenyl borate. The product of the second precipitation was radiochemically pure. In simultaneous experiments, potassium was separated from the much higher sodium activity by isotopic exchange. The irradiated sample was added to an experimentally determined inactive potassium tetraphenyl borate precipitate that adsorbed the

total potassium activity present without adsorbing any sodium. The separation of potassium by isotopic exchange had the advantage of yielding in a single step a sufficiently pure product without any sodium contamination. For comparison, sodium and potassium were also determined by flame photometry. (auth)

4566 MEASUREMENT OF THE EFFECT OF PHENOTHIAZINE ON THE MANGANESE CONCENTRATION IN THE BASAL GANGLIA OF SUBHUMAN PRIMATES BY ACTIVATION ANALYSIS. Bird, E. D.; Grant, L. G.; Ellis, W. H. (Univ. of Florida, Gainesville). pp 491-9 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

The sensitive technique of activation analysis was used to measure manganese concentration in various nuclei of the basal ganglia. Phenothiazine was given to one group of Rhesus monkeys (Macaca mulatta) for one month. One group served as a control. After sacrifice the basal ganglia were dissected out with plastic knives, dried, and duplicate samples exposed to thermal neutrons at a flux of 1.35×10^{13} n/cm^{2}s. Manganese was separated radiochemically and counts under the manganese peak were compared to a standard handled identically. The results are presented. The manganese concentration was significantly increased in the putamen of primates receiving phenothiazine. There was no significant difference in the other nuclei examined. Phenothiazine was concentrated in basal ganglia. Dopamine was found in large quantities in caudate and putamen, and following phenothiazine therapy dopamine was increased slightly. The associated increase of manganese and dopamine following phenothiazine provides some evidence that this drug causes profound biochemical alterations in the basal ganglia resulting in the various dyskinesias that were seen. (auth)

4567 HEPATIC COPPER AND CIRRHOSIS. Worwood, M.; Taylor, D. M. (Inst. of Cancer Research, Sutton, Eng.). pp 501-10 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

In an attempt to gain further information on the role of copper in cirrhosis, studies of copper metabolism were made in rats after blockage of bile flow by ligation of the bile duct. Daily injections of 100 μg of copper into rats with ligated bile ducts lead to hyperplasia of the intrahepatic bile duct and some early fibrosis. After 10 daily injections of 100 μg copper the liver copper concentration was increased about thirtyfold; there were also changes in the intracellular distribution pattern of copper in the treated animals, as determined by activation analysis. (auth)

4568 NEUTRON ACTIVATION ANALYSIS OF TRACE ELEMENTS IN PLASMA FROM NORMAL SUBJECTS AND FROM CHRONIC UREMIC PATIENTS. Giovannetti, S. (Univ. of Pisa, Italy); Maggiore, Q.; Malvano, R. pp 511-15 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

Trace concentrations of such elements as As, Au, Cu, Hg, Mo, Sb, and Zn were determined in lyophilized human plasma from normal and chronic uremic subjects by a neutron activation method. Irradiations were carried out for 24 to 120 hr in the RS 1 pool reactor, at fluxes of about 10^{13} n/cm^{2}s. Radiochemical procedures were developed to provide a sufficiently high decontamination from the prevailing activities induced in the matrix (^{24}Na, ^{32}P, ^{82}Br), a good cross-decontamination for the activities to be counted, and quantitative chemical yields. Mercury separations were carried out by a distillation method. Other elements were separated and purified by a simple, single-step column procedure allowing the successive trapping of each element in the same medium on selective beds, by a combination of different techniques (ion-exchange, isotopic exchange, reversed phase chromatography, reduction, and precipitation reactions). The experimental technique is reported and discussed, and some results are given concerning plasma from both normal and uremic subjects. (auth)

4569 TRACE ELEMENTS IN THE CEREBROSPINAL FLUID. Kjellin, K. G. (Karolinska Sjukhuset, Stockholm). pp 517-32 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

Trace elements in the cerebrospinal fluid (CSF) were determined by activation analysis and spectrophotometry (for iron). Increased CSF copper levels as compared with those of normal CSF were found in six of seven patients with a high CSF protein content (more than 100 mg/100 ml). The seventh patient, who had the lowest CSF protein content, had a CSF level within the upper half of the range for normal distribution. The copper content in CSF with increased protein content is probably affected by several other factors than the increase of the total protein contents, e.g., the serum copper content in patients with damaged blood-CSF barrier. An appreciably increased CSF copper level was found in a patient with Wilson's disease and somewhat increased values were found in two of eight patients with multiple sclerosis. Appreciably increased CSF zinc concentrations were found in three patients with a high CSF protein content as compared with those with normal CSF, and a somewhat increased value was noted in a patient with parkinsonism. The low normal values found for copper, iron, and zinc in CSF as compared with those in serum, the increased content of these trace elements found in CSF with a high protein content and the observation that copper (generally), iron, and zinc, are bound in a nonultrafiltrable form in the CSF, are in agreement with the assumption that these elements are for the most part or wholly bound to CSF proteins. Other trace metals (e.g., cobalt, chromium, gold) may also be bound to CSF proteins, as high values for these were found in patients with high protein content in the CSF. The distribution of CSF copper in the protein fractions was investigated with the electrophoretic procedure described. A copper peak with a maximum in the alpha$_2$ region was found in all cases. The normal copper content in this range was calculated to correspond roughly to 5 ng Cu/ml CSF or somewhat less. It would seem that this CSF copper fraction may be identical with the copper bound to CSF ceruloplasmin. The high copper content in the alpha region found in CSF from a patient with chronic myelomeningitis was probably due to a high concentration of CSF ceruloplasmin. The corresponding copper content in CSF from a patient with multiple sclerosis seemed to be normal. It was suggested that the loosely bound CSF iron may be bound to CSF transferrin. In vitro experiments with ^{64}Cu (0.01-0.03 μg Cu/ml CSF) showed that under the experimental conditions only a small percentage of the ^{64}Cu activity was ultrafiltrable. The nonultrafiltrable ^{64}Cu activity was for the most part recovered in the albumin zone after electrophoretic separation of the CSF concentrates. In similar electrophoretic experiments with ^{59}Fe a peak was found with the maximum activity in the beta$_1$ region. The similar electrophoretic distribution of added ^{64}Cu and ^{59}Fe activities in CSF and serum is pointed out. (auth)

4570 NEUTRON ACTIVATION FOR STUDYING HYDROELECTROLYTIC DISORDERS IN CHILD PATHOLOGY. Dubois, J. (Univ. St-Pierre, Brussels); Colard, J.; Vis, H. L. pp 545-56 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967. (In French).

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

A method of determining electrolytes (Na, K, Cl) and phosphorus in small fragments of muscle taken from child patients by needle biopsy is described. This method was used to study muscular disturbances in hydroelectrolytic illnesses of childhood, whether acute, such as dehydration or toxicosis in infants, or chronic, such as malnutrition or marasmus. The results are discussed in the light of parallel data obtained by other methods of investigation. The possibility of using this method to estimate intracellular hydroelectrolytic disorders in child pathology is also discussed. (auth)

4571 TRACE ELEMENT ANALYSIS OF HUMAN LUNG TISSUE BY NEUTRON ACTIVATION AND INSTRUMENTAL ANALYSIS. Perkins, R. W. (Battelle-Northwest, Richland, Wash.); Haller, W. A.; Thorpe, J. D. pp 557-66 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

An analytical technique based on neutron activation for measurement of trace elements in tissues was developed that requires a minimum of pre-irradiation handling followed by the direct measurement of the activation products on a multidimensional or a solid-state γ spectrometer. This technique was applied to a study of trace elements in human lung tissue. Lung tissue contains not only the tissue-bound elements but also those that were deposited in the cells of the pulmonary alveoli through inhalation. The method permits the direct measurement of 15 trace elements. The analysis of lung tissues thus provides information on the integrated trace element deposition resulting during the life of an individual. The concentrations of several of these including Fe, Br, P, Se, Ag,

Zn, Cs, Co, Sc, U, and Sb were measured in several autopsy and biopsy samples of both normal and diseased tissues from several subjects with known case histories. The variations in the observed trace element compositions are presented and considered in terms of the occupational and medical history of the subject. (auth)

4572 DETERMINATION OF CHROMIUM CONTENT IN HUMAN SKIN BY MEANS OF NEUTRON ACTIVATION ANALYSIS. van Kooten, W. J. (Univ., Nijmegen, Netherlands); Mali, J. W. H.; de Goeij, J. J. M.; Houtman, J. P. W. pp 567-72 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

An investigation was started in which the chromium content in the skin was compared for eczema patients and normal people. The sample weight (10 mg) and the chromium content (0.2 to 0.4 ppm) involved required a sensitive technique. Neutron activation analysis was well suited to this purpose. Under our operation conditions (irradiation time 10 days, neutron flux 10^{14} n/cm^{2}s) it was possible to determine quantities as low as 5×10^{-11} g of chromium. Preliminary experiments showed relatively large variations in chromium content of comparable samples, even in skin samples taken from the back of a single person. It was further suggested by the results of these experiments that the chromium content in the skin of eczema patients is lower than in that of normal patients. The results of the analysis may be seriously affected by chromium contamination during sample preparation. Therefore chromium-free instruments must be used. To avoid chromium migration in the skin due to degeneration processes, samples must be taken from persons alive or shortly after their death. (auth)

4573 EXPERIMENTS RELATING TO WHOLE-BODY ACTIVATION ANALYSIS IN MAN IN VIVO USING 14-MeV INCIDENT NEUTRONS. Battye, C. K.; Tomlinson, R. W. S.; Anderson, J.; Osborn, S. B. (King's College Hospital and Medical School, London). pp 573-82 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

The possibility of using 14-MeV incident neutrons for neutron activation analysis in vivo in man is dependent upon: uniformity of slow neutron flux, uniformity of detection, and absence of interfering reactions. Experiments are described in which the thermal and fast neutron fluxes in a phantom representing a man were determined as a function of depth by the activation of solutions of body elements. The uniformity of slow and fast fluxes in a bilateral irradiation, and the optimum conditions for obtaining a uniform slow flux, are discussed. The ratio of fast to slow flux over the uniform region is deduced. The thicknesses of a group of subjects were measured to determine the required depth of uniform flux. The results are given of experiments to determine the extent to which some reactions interfering with the determination of sodium, chloride, and calcium occur. These results are compared with calculated values. In the case of $^{24}Mg(n,p)^{24}Na$, interference was found to be 3.4%. The activity of ^{37}S produced by the reaction $^{37}Cl(n,p)^{37}S$ was 13.2% of the activity produced at 3.1 MeV by ^{40}Ca. (auth)

4574 CLINICAL EXPERIENCE OF IN-VIVO ACTIVATION ANALYSIS OF IODINE IN THE THYROID GLAND: AN ASSESSMENT OF THE PROBLEMS. Boddy, K. (Scottish Research Reactor Centre, East Kilbride, Scotland); Alexander, W. D. pp 583-97 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

Preliminary studies described earlier were extended to the measurement of iodine in the thyroid glands of patients with nontoxic goitre. A collimated beam of neutrons from the UTR-100 kW reactor irradiated the patient's thyroid producing ^{128}I and, incidentally, other isotopes, principally ^{24}Na and ^{38}Cl. It is shown that the simple procedure of inserting boron or cadmium in the beam reduces the activity of these latter unwanted isotopes compared with the activity of ^{128}I. A shadow-shield thyroid monitor, developed specially for these studies, was used to measure the induced activity. Sensitivities of about 1 mg or less of thyroidal iodine were attainable with a dose to the gland estimated pessimistically as about 14 rem and more realistically as about 6 rem. Problems experienced with the irradiation and counting techniques and the interpretation of the results are assessed and the progress made in overcoming these difficulties is described. Comparisons of results from in-vivo measurements and from in-vitro activation analysis and biochemical analysis on the same gland after thyroidectomy showed that there was good agreement between the in-vivo and in vitro activation results, but the values from these analyses, although in reasonable agreement with, tend to be higher than, the biochemical results. The reasons for this are still being investigated. (auth)

4575 ACTIVATION ANALYSIS AND PUBLIC HEALTH. Survey Paper. Lenihan, J. M. A. (Western Regional Hospital Board, Glasgow); Smith, H. pp 601-14 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

The technique of activation analysis has useful and distinctive applications, not yet fully recognized or exploited, in public health. Three areas of usefulness may be recognized: Industrial hygiene. Activation analysis offers a simple and efficient method for assessing and controlling occupational hazards associated with the handling of toxic materials, such as compounds of arsenic and of mercury. Examination of hair and nail samples, taken at six-month intervals, will yield a surprising amount of information regarding the influence on occupational exposure of individual variation in working habits, and inadequacy or nonobservance of hygienic rules and other prescribed safety measures. Epidemiology. The advantage conferred by activation analysis lies in the possibility of rapid and accurate estimation of trace element concentrations in small samples of tissue or other materials, such as can readily be obtained from population groups large enough to be statistically significant. Surveys of this kind have interesting potentialities in relation to dental caries, cancer, cirrhosis of the liver, and heart disease. Recognition of essential trace elements. Surveys of trace element concentrations suggest that the variability of tissue levels among members of a population is smaller for essential trace elements than for non-essential elements. It is possible also that tissue levels show a normal distribution for essential elements and a log-normal distribution for nonessential elements. (auth)

4576 ACTIVATION ANALYSIS IN STUDIES OF AN AQUATIC ECOSYSTEM. Merlini, Margaret; Girardi, F.; Pozzi, G. (EURATOM-CCR, Ispra, Italy). pp 615-29 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

A study was undertaken of certain elements associated with reactor effluents and radioactive waste disposal (Mn, Cu, Zn, Cs, Co, Fe, and Sr) in different components of the Lago Maggiore and the Creek Novellino. Such information for an aquatic ecosystem entails the analyses of a large number of highly diversified samples: water, sediment, plants, and animals. The project was made feasible by the use of automated neutron activation analysis procedures employing a semiconductor and electronic computers. The results obtained are discussed in the light of contamination of the aquatic ecosystem by the radioactive isotopes of the above-mentioned elements, and their distribution among the different components investigated. (auth)

4577 USE OF RADIOACTIVATION ANALYSIS IN MEDICINE. Comar, D.; Kellershohn, C. (CEA, Orsay, France). pp 403-17 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967. (In French).

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

Three aspects of radioactivation analysis are of current interest in medical research. Its very high sensitivity makes this method suitable for the detection and precise measurement of a large number of elements of undoubted physiological interest, particularly where the conventional methods of analytical chemistry cannot be used. In view of the fact that it can be used to determine a particular stable isotope of an element, activation analysis is also employed to follow what happens to a stable tracer in man. It is of especial value for studying very slow processes where use of a radioactive tracer is impossible or dangerous. In certain cases activation analysis can be used as a nondestructive method, making it possible for the total mass of an element in the organism (or a part thereof) to be determined in vivo. A number of examples are given to illustrate the three above-mentioned medical applications of activation analysis. (auth)

4578 NEUTRON ACTIVATION ANALYSIS OF LEAD HALIDE POLLUTION AEROSOLS. Winchester, J. W. (Univ. of Michigan, Ann Arbor); Duce, R. A. pp 631-43 of Nuclear Activation Tech-

niques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

Iodine, bromine, and chlorine were determined by neutron activation analysis in atmospheric samples of both natural and pollution origin, and a comparison of the two sources provided the basis of a technique described for determining the composition and possible source of lead halide pollution aerosols. The activation analysis procedure employed consisted of reactor neutron irradiation of aqueous samples and comparators for 20 min followed by radiochemical separation of iodine, bromine, and chlorine and automatic counting of β-radioactivity from solid silver halide sources. Determination of lead by anodic stripping voltammetry (inverse polarography) consists of deposition of Pb^{2+} from the solution onto a composite paraffin-impregnated graphite and mercury electrode at −1.00 V versus the standard calomel electrode, and then stripping by increasing the potential continuously. A significant question of public health interest in the air chemistry of lead is the source of the lead. Ethyl fluid, a mixture of organic lead, bromine, and chlorine compounds, burns to form inorganic lead halide particles with Cl/Pb = 0.34 and Br/Pb = 0.39 by weight. In Cambridge, Massachusetts, analyses of cascade impactor aerosols were compared with similarly collected samples from the unpolluted air of Hawaii. The pollution bromine component ranged from 0.4 to 0.1 or less of the lead concentration, indicating in most cases either automotive lead with a bromine deficiency or a mixture of lead from automotive and other sources. In Fairbanks, Alaska, during winter, atmospheric conditions favor high local concentrations of air pollutants. Aerosols collected by Millipore filters show that pollution chlorine averages very nearly the value predicted from the observed lead and the known composition of ethyl fluid, and the automotive source for both chlorine and lead is strongly indicated. Pollution bromine, however, was less than predicted, and the bromine deficiency was about the same in Fairbanks and in Cambridge. These results imply that ethyl fluid combustion is the major source of atmospheric lead in Cambridge as well as in Fairbanks, and the observed pollution bromine and chlorine come predominantly from the same source. (auth)

4579 ACTIVATION ANALYSIS IN FORENSIC SCIENCE. Survey Paper. Jervis, R. E. (Univ. of Toronto). pp 645-59 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

A review of the principal forensic activation analysis applications to biological materials to date indicates that they may be roughly classified as: the detection and determination of residues of toxic materials in foodstuffs, human tissues, sera, and excreta; the individualization of hair, fibres, narcotics, and drugs; and investigation of the transference of ballistic material to bone, cloth, or paper. Analyses of these materials in some actual forensic investigations were perfected to the point of acceptance in the law courts of several countries. Additional and broader areas of application are under development in a number of nuclear and forensic laboratories. The determination of submicrogram quantities of phosphorus compounds, arsenic, mercury, selenium, and thallium in specimens from post-mortem examinations and from living persons showing symptoms of toxicity revealed certain ingestion of abnormal amount of toxic substances by comparison with similar specimens from healthy persons. In some cases, with tissues such as hair and nails, the time scale of the ingestion of arsenic or mercury was revealed through the distribution of the deposited element with distance from the growing end or edge. A series of feasibility studies on the possibility of distinguishing similar materials through their characteristic trace-element patterns have resulted from observations of the wide range or variation in trace impurity content in specimens that come from different individuals or different natural sources. For example, extensive activation analyses for more than twenty elements in human head hair from many people were carried out and a statistical analysis of the results indicated that activation hair comparisons in forensic investigations may be quite definitive provided sufficient hair sample is available and enough trace constituents are determined. Similar analyses of heroin, opium, and marijuana narcotics, synthetic drugs and of fibres were made in attempts to characterize such materials according to source supply. Methods were developed for multielement analyses of blood in order to assess its individuality from person to person. Wounds, holes in apparel, and deposits on suspects' hands were identified as arising from gun shots through the detection of increased traces of barium and antimony on bone, skin, or on adjacent surface areas and similar techniques were applied to estimate the distance from a weapon to the target in cases of reputed suicide or homicide. (auth)

4580 SORPTION BEHAVIOUR OF TRACE ELEMENTS IN HUMAN HAIR. van den Berg, A. J.; de Bruin, M.; Houtman, J. P. W. (Reactor Inst., Delft, Netherlands). pp 661-79 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

Adsorption and desorption experiments are described by which it was possible to obtain more quantitative data about mass transport into and out of the hair. In these experiments use was made of tracer techniques as well as neutron activation analysis. The overall change in the concentration of trace elements in hair can be described mathematically as a rapid adjustment of an adsorption equilibrium at the hair surface followed by a slow diffusion through the cylindrical hair. Diffusion constants for a number of ions were found to lie between 10^{-13} and 10^{-18} m^2/s. Moreover, the maximum uptake of elements can vary over several orders of magnitude. Some consequences of these findings in crime detection are discussed. (auth)

4581 ACTIVATION ANALYSIS OF BIOLOGICAL SAMPLES OF FORENSIC INTEREST. Bryan, D. E.; Guinn, V. P.; Settle, Dorothy M. (General Dynamics Corp., San Diego, Calif.). pp 681-94 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

The forensic applications of high-flux thermal-neutron activation analysis (NAA) show great promise and are attracting considerable attention. Such forensic NAA research and development studies over the past five years are reviewed. In the United States, NAA results were successfully presented in court in some 20 actual cases. Some of the evidence-type materials of interest are nonbiological; others are biological. Only the latter are discussed. The principal evidence-type materials of a biological nature that were examined in this laboratory by high-flux thermal-NAA to date are the following: hair, blood, feces, urine, fingernails, skin, wood, tobacco, whisky, green plants, and marijuana. (In addition, a number of these evidence-type materials were also studied in this laboratory by high-flux photonuclear activation analysis (PNAA); attention in this paper will be largely devoted to the thermal-NAA forensic studies.) The main topics reported on are: limits of detection attainable by high-flux thermal-NAA (especially with the purely instrumental, nondestructive form of the method), the philosophy of sample comparisons by means of their trace-element levels, the statistical interpretation of trace-element comparisons of evidence samples, trace-element results obtained on many of the sample types mentioned above, applications of NAA by high-intensity reactor pulses, and of PNAA, in forensic studies, and computer techniques used in processing activation analysis data. The experimental work described in this paper is carried out with the three TRIGA reactors, the two electron linear accelerators, and the Univac-1108 computer at the laboratory. (auth)

4582 INVESTIGATION OF THE DISTRIBUTION OF RARE ELEMENTS BETWEEN THE VARIOUS PHASES OF STONE METEORITES BY NEUTRON ACTIVATION ANALYSIS. Lavrukhina, A. K.; Kashkarov, L. L.; Kolesov, G. M.; Genaeva, L. I. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Acta Chim. Acad. Sci. Hung., 57: 353-62(1968). (In Russian).

The sensitivity of neutron activation analysis for the determination of Sc, Ba, Ce, and Eu in stone meteorites and iron meteorites has been calculated. The analysis is based on the measurement of the activity of the isotopes ^{46}Sc, ^{131}Ba, ^{141}Ce, ^{143}Ce, ^{152m}Eu, ^{153}Eu and ^{140}Ba. Activities for various times of irradiation were measured with a low-background 4π-counter using carrier gas, with an end-window Geiger-Müller counter, and with a γ spectrometer equipped with a 100-channel pulse analyzer. The minimum quantity of the meteorite sample to be weighed in at given quantities of the said elements was determined. By way of example, Sc, Ba, Ce, Eu, and U analysis results obtained on dark and light variants of hypersten chondrites, found in the vicinity of the places "Kunasak" and "Pervomaiskii Posyolok" are presented. The possibilities of the determination of U and Th in mica, tektites, and iron meteorites on the basis of the path of products of nuclear fission, induced by reactor neutrons, are discussed. (auth)

4583 INVESTIGATION OF TUNGSTEN BY NEUTRON ACTIVATION ANALYSIS. II. DETERMINATION OF THE SODIUM AND POTASSIUM CONTENT. Elek, A.; Szabo, E. Acta Chim. Acad. Sci. Hung., 57: 385-9(1968). (In Russian).

A method has been developed for the determination of the sodium and potassium content of tungsten filaments. The samples were irradiated in a WWR-Sz type reactor by means of the pneumatic tube system. After irradiation, a selective separation by ion-exchange of the tungsten was effected. A 3 × 3 in. NaI(Tl) crystal and a multichannel analyzer were used for the activity measurements of the ^{24}Na and ^{42}K isotopes. Under the given experimental conditions, the sensitivity of the method was 0.005 μg Na and 0.2 + 0.5 · m_{Na} − μg K, where m_{Na} denotes the amount of Na in the samples, in μg. (auth)

4584 MOESSBAUER SPECTRA OF DEEP-SEA IRON–MANGANESE NODULES. Gager, H. M. (Virginia Inst. for Scientific Research, Richmond). Nature (London), 220: 1021-3(Dec. 7, 1968).

Moessbauer spectroscopy, together with other methods, was used to determine the iron content of Atlantic and Pacific nodules. It was interesting that despite the relatively high percentage of iron present, no specific Fe-containing minerals could be identified by X-ray diffraction. The Moessbauer spectra were investigated using a constant acceleration spectrometer, with a multichannel analyzer operated in the multiscalar mode. Spectral details are tabulated. The spectra of unheated samples showed a quadrupole doublet of 0.6 mm/s, with an isomer shift of +0.6 mm/s, consistent with a high spin ferric compound. There were no differences in the spectra of samples from different locations. When recovered from the ocean floor the nodules are non-magnetic, but they become magnetic on heating at 650°C, and the most strongly magnetic sample was that with the highest Fe content. Its spectrum showed a six-line pattern with a hyperfine field of 500 k oersteds and a superimposed doublet having a quadrupole splitting of 1.2 mm/s and an isomer shift of +0.6 mm/s. The magnitude of the hyperfine field was consistent with a spinel structure containing $Mn_xFe_{3-x}O_4$, where x = 0 or <1. The central doublet was larger than expected for a mixture of large and small particles, and was probably due to some variation of the substitution of Fe and Mn in the lattice sites. The Moessbauer patterns of calcined samples showed only a doublet. The spectra were consistent with the presence of lepidocrocite or geothite in a finely divided state. (UK)

4585 ARSENAZO III AS A METALLOCHROMIC INDICATOR FOR THE DIRECT DTPA TITRATION OF LANTHANONS IN ALUMINO-SILICATE ZEOLITES. Marsh, William W. Jr.; Myers, George Jr. (Sun Oil Co., Marcus Hook, Pa.). Anal. Chim. Acta, 43: 511-14(1968).

A method is described for the direct titration of total rare earths in aluminum silicate zeolites, such as molecular sieve catalysts, with [(carboxymethylimino)bis(ethylenenitrilo)] tetraacetic acid (DTPA). When used in the system described, arsenazo III offers advantages over the commonly used indicators, such as xylenol orange, methylthymol blue, or arsenazo I. Sulfosalicylic acid masks Al(III) and Fe(III) do not have to be removed. Large amounts of sulfate can be tolerated, and the accuracy and precision are superior to those for the classical oxalate precipitation gravimetric method. The rapidity of the titration and the superiority of arsenazo III under various conditions suggest broad applicability for the method. (P.C.H.)

4586 DETERMINATION OF ^{85}Kr IN AQUEOUS SOLUTION BY CHERENKOV COUNTING IN WATER AND POLYETHYLENE. Buchanan, John D. (Palo Alto Labs., Calif.). Radiochim. Acta, 9: 218-20(Oct. 1968).

Cherenkov counting with a commercial liquid scintillation counter was found to be more sensitive than other methods reported for the direct determination of ^{85}Kr in aqueous samples, but not as sensitive as methods involving gas stripping and gas-phase counting. The principal advantage of the method is that essentially no sample preparation is required if the concentrations of the potential interferences (radionuclides which emit hard betas, and luminescent or colored materials) are sufficiently low. The method can be used for the direct, continuous measurement of a water stream. Krypton-85 can be separated from water for Cherenkov counting by diffusion into polyethylene. The Cherenkov counting efficiency of ^{85}Kr was found to be nearly three times as great in polyethylene as in water. Other radioactive gases emitting hard betas, or having decay products which emit hard betas, could also be determined in water and polyethylene by Cherenkov counting. (D.H.M.)

4587 RADIOCHEMICAL CONFERENCE, BRATISLAVA, SEPTEMBER 6–10, 1966. Abstracts of Papers. Rez, Czech., Institute of Nuclear Research, 1966. 98p. (CONF-660966).

Abstracts of ninety-three papers are presented. Subjects include extraction studies, ion exchange separations, production of radioisotopes, substoichiometric analyses, radiochemical separations and analyses, labeling methods, isotopic exchange and separations, and activation analyses. (J.G.B.)

4588 RESEARCH ON THE X-RAY LUMINESCENCE METHOD. I. A CONVENIENT X-RAY LUMINESCENCE SPECTROMETER AND ITS APPLICATION TO ANALYSIS OF RARE EARTHS IN YTTRIUM OXIDE. Sasaki, Naohisa (Mitsui Mining and Smelting Co., Ltd., Tokyo). Bunseki Kagaku, 17: 1387-95(Nov. 1968). (In Japanese).

An x-ray luminescence spectrometer has been developed for measuring the x-ray-excited emission spectra. The apparatus is assembled with x-ray excitation units of an x-ray spectrometer (Rigaku Denki Model K-3 with Machlett OEG-50 tube tungsten target) and a spectrophotometer (Hitachi Model 139 with QPD-53 recorder). A single convex lens (f = 35 mm) is used at the connection part. The x-ray source gives no interference with emission spectra, because x rays are not reflected, and hence the apparatus can be easily assembled. Discoloration of lens due to x radiation has not appeared even after a year. Emission intensity and sensitivity as functions of x-ray tube and spectrophotometer conditions were studied. Rare earths in yttrium oxide were determined with sensitive results. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 4662, 4673, 4674, 4702, 4738, 4845, 4846, 5490, and 5491.

4589 (ANL–7358) ENERGY LEVELS AND INTENSITIES IN THE SOLUTION ABSORPTION SPECTRA OF THE TRIVALENT LANTHANIDES. Carnall, W. T.; Fields, P. R.; Rajnak, K. (Argonne National Lab., Ill.). Mar. 1968. Contract W-31-109-eng-38. 92p. Dep. CFSTI.

A theoretical interpretation of the solution absorption spectra of the trivalent lanthanides is presented. The extent to which experimentally measured energies and intensities of the bands can be correlated with those computed from theory is examined. The comparison technique was used to identify as many levels as possible in the solution spectrum of a given lanthanide. The next step was to determine values for the interelectronic repulsion and spin-orbit coupling parameters that would generate a set of calculated energy levels in good agreement with the observed data. The description of states implicit in these parameters was then used directly in the intensity calculations. The intensity calculations were used as a basis for making numerous new assignments to bands observed in the uv region. Sets of electrostatic and spin-orbit parameters were then derived by a least-squares analysis of data which included the new assignments. Thus the intensity calculations became a tool for elucidating the energy-level structure of all of the hydrated lanthanide ions. (74 references). (P.C.H.)

4590 (ANL–7441) CRYSTAL STRUCTURES OF CUBIC AND TRIGONAL YTTRIUM HYPOCARBIDES; A DIMORPHICALLY INTERPHASED SINGLE-CRYSTAL STUDY. Atoji, M.; Kikuchi, M. (Argonne National Lab., Ill.). May 1968. Contract W-31-109-eng-38. 68p. Dep. CFSTI.

The single-crystal structure determination is presented for yttrium hypocarbide, which exhibits two modifications: the high-temperature-disordered cubic structure having the composition YC_x ($x \cong 0.25 - 0.65$), and the low-temperature-ordered trigonal structure with the Y_2C stoichiometry. Both x-ray single-crystal and neutron powder techniques were employed in the structure determination. The quenched single crystal used has stabilized the transient state in the midst of the cubic-to-trigonal transition, and consists of one cubic and four trigonal crystals with the trigonal triad axis parallel to one of four cubic triad axes. The domain sizes of these five crystals are different from one another, resulting in highly complex diffraction patterns for which exceedingly elaborate dimensional and intensity interpretations have been carried out. The chemical compositions of the sample crystal were determined accurately by means of the diffraction-intensity analysis. Several new statistical and analytical methods have been derived and incorporated in the study. The cubic structure, $YC_{0.43}$, has been uniquely determined to be a NaCl-type with a = 5.115 ± 0.002 Å and with the carbon atom sites randomly occupied. The trigonal Y_2C shows an anti-$CdCl_2$-type configuration with a = 3.617 ± 0.002 and c = 17.96 ± 0.01 Å. The carbon atoms are located at the nonparameter positions, and the Y atoms are found at the one-parameter coordinates with z = 0.2585 ± 0.0003. The Debye temperatures obtained from the isotropic temperature factors are 230 ± 10, 170 ± 5, and 233 ± 6°K for $YC_{0.28}$ (cubic), $YC_{0.43}$ (cubic), and Y_2C (trigonal), respectively.

The cubic-to-trigonal transformation is characterized by a slight yttrium-layer displacement along the triad axis and a migration of the carbon atoms to constitute a full and vacant layer sequence. The multidomained single-crystal structure demonstrates an illuminating example of interphase and isophase boundary intercorrelation. Revelation of such interphased structure is also the first example in this type of compound. The cubic YC_x structure has previously been postulated and the trigonal Ho_2C structure has also been reported, both through the powder technique. These results were confirmed unambiguously and the structure parameters are presented with a substantially higher accuracy, hence providing detailed insight into the chemical bonding and the phase-transition mechanism. A review of the related structures is given to emphasize striking differences in the bond properties between the rare-earth and transition metal carbides. The crystal structure of Sc_2C, previously reported incorrectly as having a cubic superlattice, has been proved to be isostructural to the trigonal Y_2C. (auth)

4591 (IPP–2/71) MEASUREMENT OF BARIUM VAPOR DENSITY. Hinnov, E.; Ohlendorf, W. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). July 1968. 17p. Dep.

The density of atomic barium emitted from a small aperture in a uniformly heated stainless-steel oven was measured by the method of resonance fluorescence. The range of the oven temperature was 730 to 1200°K. At lower densities, the resonance transition 6 s^2 $^1S \leftrightarrow$ 6 s p ^1P was used for the density measurements, at higher densities the forbidden transition $6s^2\,^1S \rightarrow 6pSd\,^3P$ or ^3D, followed by emission through the allowed transitions to $6s5d\,^3D$. From the measured spatial distribution of the density above the aperture, the equilibrium vapor density in the oven was deduced. The latter can be expressed empirically reasonably well by the formula, $N_0(T) = 1.6 \times 10^{22} \exp[-19000/T]\ cm^{-3}$, with the temperature T in °K. At temperatures higher than 1000°K the measured densities were progressively slightly lower than this formula predicts. However, the deviation could be due to certain systematic errors in the measurement, which became progressively more serious with increasing density. In addition to the barium density, the measurements yielded some information on the atomic transitions employed, generally confirming previous knowledge in this matter. (auth)

4592 (RISO–169) STUDIES ON SULFONIC ANHYDRIDES. Christensen, N. Hesselbjerg (Danish Atomic Energy Commission, Risoe. Research Establishment). Apr. 1968. 107p. Dep.

Thesis. Submitted to Technical Univ. of Denmark, Lyngby.

The formation of a sulfonic anhydride in aromatic sulfonation can be utilized in a very simple way for the preparation of ^{35}S-labelled p-iodobenzenesulfonic anhydride, a reagent that is applied for the determination of submicrogram quantities of hormones in blood-serum. The formation of sulfonic anhydrides in sulfonation is reviewed. The reaction is discussed in terms of the equilibria $RSO_2SO_3H \rightleftharpoons RSO_3H + SO_3$ and $RSO_3H + RSO_3SO_3H \rightleftharpoons (RSO_2)_2O + H_2SO_4$. The occurrence of these reactions, which are usually not considered in studies of sulfonation, is not inconsistent with previous hypotheses of sulfonation mechanisms, which are also reviewed. The sulfonylating properties of sulfonic anhydrides are reviewed and compared with those of the sulfonyl chlorides. As a special case of sulfonylation, the hydrolysis of some sulfonic anhydrides was studied kinetically and found to be much faster than hydrolysis of sulfonyl chlorides. Various methods of determining the mechanism of these solvolytic reactions are discussed. The kinetic solvent isotope effect was measured. (160 references) (auth)

4593 HYDROGEN ISOTOPE EQUILIBRIA IN THE SYSTEM HYDROGEN–WATER. Bottinga, Yan (Scripps Institution of Oceanography, La Jolla, Calif.). J. Phys. Chem., 72: 4338–40 (Nov. 1968).

Values of the equilibrium constant K_1 for the equation $H_2O + D_2O = 2HDO$, K_2 for the equation $H_2 + D_2 = 2HD$, and K_3 for the equation $H_2O + HD = HDO + H_2$ were calculated over the temperature interval 0 to 600°C, in both harmonic and anharmonic approximation. Results show a disagreement between the observed and calculated values of K_1; however, an agreement between observed and calculated values for K_3 was obtained. Calculated equilibrium constants at 25°C are K_1 = 3.83 harmonic, 3.40 anharmonic; K_2 = 3.24 harmonic, 3.20 anharmonic; and K_3 = 4.17 harmonic, 3.50 anharmonic. (D.H.M.)

4594 KINETIC STUDY OF THE BROMINATION MECHANISM OF TERTIARY AROMATIC AMINES. IV. ISOTOPE EFFECT. Dubois, J.-E.; Uzan, R. (Faculte des Sciences , Paris). Bull. Soc. Chim. Fr., No. 9, 3534–9(Sept. 1968). (In French).

The bromination rate constants of four aromatic N,N-dimethylamines and their ring deuterated analogues were measured at 25°C in water. The isotope effect, k_H/k_D, for an attack para to $N(CH_3)_2$ in n,n-dimethyl-2,6-xylidine and ortho to the same group in 4-bromo-N,N-dimethylaniline was equal to 1 and 8.5, respectively. The isotope effect had a value of about 2 for n,n-dimethyl-3,4-xylidine and n,n-dimethyl-p-toluidine. The explanation of these results, in terms of the $\bar{S}E2$ mechanism, led to kinetic equations which predict the bromide ion effect on k_H/k_D. This prediction was confirmed experimentally. (auth)

4595 REVERSIBLE HYDRATION OF AMINOSTYRENES. Jensen, James Leslie. Seattle, Univ. of Washington, 1967. 244p.

Thesis.

Kinetic parameters for reversible hydration of several meta- and para-aminostyrenes were measured in aqueous $HClO_4$. It was found that hydration occurs via two processes. In more dilute acid media, the rate is independent of the acid concentration per se, the reaction is general base catalyzed, and the solvent isotope effect, k_{H_2O}/k_{D_2O}, is ~10. In more concentrated acid media, the rate is steeply dependent on the acidity [the slope of d(log k_{obs})/d(-H_0) is ~1.1] and the solvent isotope effect, k_{H_2O}/k_{D_2O}, is ~2. The region of acidity in which the first process predominated over the second process was studied in detail. The activity coefficient ratio, f_{SH^+}/f_{tr^+}, for the hydration of p-aminostyrene increased with increasing acid molarity, whereas the activity coefficient ratio, f_{SH^+}/f_{tr^+}, for the hydration of p-dimethylaminostyrene decreases with increasing acid molarity. This was consistent with the anilinium ion being more strongly solvated than the N,N-dimethylanilinium ion and therefore losing more in way of free energy of solvation as the activity of water is decreased. The solvent isotope effect on the hydration of any particular aminostyrene remained constant over the range of acidity in which the first process is predominant. The solvent isotope effects on the hydration (via the first process) of m-dimethylamino-α-methylstyrene, p-dimethylaminostyrene, and p-dimethylamino-α-methylstyrene are 7.20, 12.2, and 11.0, respectively. This order is consistent with the bonding in the transition state for the hydration of p-dimethylaminostyrene being the most symmetrical. (Disser. Abstr.)

4596 DEUTERIUM ISOTOPE EFFECTS IN THE DECOMPOSITION OF ORGANOMETALS BY PROTON DONORS. Exner, Jurgen Hans. Seattle, Univ. of Washington, 1968. 198p.

Thesis.

Deuterium isotope effects associated with proton transfer from oxygen acids and hydrocarbon acids to the phenyl and benzyl derivatives of Mg, Li, and Na in diethyl ether and in tetrahydrofuran (THF) were determined. Isotope effects were determined by a competitive method, consisting of the addition of a solution of the organometal to a large excess of an equimolar mixture of the proton and deuteron donor. The products, RH and RD, were isolated and then analyzed on a mass spectrometer. For strictly irreversible processes, the ratio RH/RD is equivalent to the isotope effect, k_H/k_D. The formation of RH, due to proton abstraction from traces of water and from solvent, was determined by quenching aliquots of the freshly prepared organometals with D_2O. The D isotope effects for proton transfer from the oxygen acids to the organometals are small, varying between 1.0 and 1.5. The absence of a relationship between the acid strength of the proton donor and the isotope effect associated with transfer from it, coupled with a relatively large isotope effect for transfer from a sterically hindered phenol, very strongly suggests that these reactions proceed by coordination of the oxygen acid to the metal atom of the organometal, followed by proton transfer. The rates of reaction of Grignard reagents with phenylacetylene, indene, and fluorene were determined by an aliquot method. The initial rates of the reactions appear to be first-order in each reactant. The rates of reactions in THF are much faster than in diethyl ether and increase with increasing acidity of the hydrocarbons. Relative rates of reaction between phenyl- and benzyllithium and four hydrocarbon acids in THF were estimated by a competitive method. Benzyllithium abstracts a proton faster than phenyllithium from indene, fluorene, and triphenylmethane, but for abstraction from phenylacetylene the rates are about equal. Isotope effects for proton transfer from hydrocarbon acids to organometals are large, ranging from 1.4 to 10.8. In the reactions of one organometal with the series of hydrocarbons in THF, the isotope effect appears to be a function of the rate of reaction. The isotope effect for the reaction of phenyllithium with phenylacetylene is 1.4, with indene 6.5, with fluorene 8.2, with biphenylyldiphenylmethane 4.7, and with triphenylmethane 4.6. Taking the pK_a of the hydrocarbon as a measure of its reactivity, a plot of isotope effect vs pK_a of the hydrocarbon gives three curves for phenyllithium, benzyllithium, and benzylsodium. These curves indicate that the isotope effect for the reactions of each organometal with the

series of hydrocarbons reaches a maximum and then decreases. This represents experimental support for recent theoretical predictions of a maximum in the isotope effect for a series of closely related reactions. The data are discussed in terms of the maximum isotope effect theory, and suggestions regarding the transition states for these processes are made. The position of the maximum in the isotope effect for proton transfer to each of the three organometals varies and may be an indication of the reactivity of the organometallic compound. (Disser. Abstr.)

4597 METHOD FOR PRODUCING AMMONIUM URANATE. Ono, Masayoshi (to Nippon Atomic Industry Group Co., Ltd.). Japanese Patent 1968-11663. May 16, 1968. Filed Aug. 31, 1964.

Ammonium uranate, containing tetravalent U, as an intermediate for the production of nuclear fuel is prepared by the reaction of UF_6, a reducing gas, and HN_4OH. Alternatively, UF_6 and a reducing gas are allowed to react with each other, and then the reaction product is reacted with NH_4OH. (NSA of Japan)

4598 ISOTOPIC FRACTIONATION IN THE SYSTEM: CALCITE–GRAPHITE–CARBON DIOXIDE–METHANE–HYDROGEN–WATER. Bottinga, Yan. San Diego, Calif., Univ. of California, 1968. 142p.

Thesis.

Isotopic fractionation factors were calculated for D exchange between H_2, H_2O (vapor), and CH_4, for ^{13}C exchange between graphite, calcite, CO_2, and CH_4, and for ^{18}O exchange between calcite, CO_2, and H_2O (vapor). Reduced partition function ratios for $H_2^{18}O/H_2^{16}O$, $C^{18}O_2/C^{16}O_2$, $CaC^{18}O_3/CaC^{16}O_3$, $^{13}CO_2/^{12}CO_2$, and $Ca^{13}CO_3/Ca^{12}CO_3$ are tabulated. Calcite partition function ratios are calculated using the Giulotto–Loinger model for the acoustical, optical, and librational lattice modes; the orbital-valence-force-field method was used for the carbonate ion vibrational frequencies. The graphite calculations are based on the Yoshimori-Kitano model for which the ^{12}C and ^{13}C phonon spectra were computed. Water vapor, CH_4 and CO_2 were treated as ideal gases with vibrational anharmonicity; rotation of CH_4 and H_2O (vapor) was treated as nonclassical. The CH_4 internal equilibrium constants for mixed molecule exchange deviate significantly from the high-temperature "classical" values even at 800°C. Calculated fractionation factors for D exchange between H_2 and H_2O vapor agree with observed values. The calculated internal equilibrium constant for H_2O vapor disagrees with recent experimental data, possibly due to experimental effects. Carbon-13 and ^{18}O fractionation observed by others in the system calcite-CO_2 are in good agreement with the theoretical calculations, showing that at least in some cases good calculations can now be made for polyatomic solids. Oxygen-18 fractionation factors for isotopic exchange between CO_2 and H_2O were measured in the temperature interval 0 to 45°C; the measured values are in agreement with the calculations. Oxygen-18 fractionation between water and steam was measured over the temperature interval 135 to 300°C. In contrast to the well-known "cross-over" effect for D, ^{18}O concentrates preferentially in the liquid phase over the entire temperature range. Some geochemical applications of the calculated and experimental data are discussed. (Disser. Abstr.)

4599 EFFECT OF WATER ON THE DISTRIBUTION OF URANYL 8-QUINOLINOL CHELATE BETWEEN NITROMETHANE AND 1-DECANOL. Motley, Richard; Meloan, Clifton E. (Kansas State Univ., Manhattan). Separ. Sci., 3: 285-96(June 1968).

An equation of the form $y = AB^{e^{cx^n}}$ describes the effect of associated water on the distribution ratio of this nonaqueous extraction. It was also determined that there are 9.6 ± 1.5 molecules of water associated per molecule of the chelate when extracted from water into nitromethane or 1-decanol. (auth)

4600 I. THE ELECTROMOTIVE FORCES AND THERMODYNAMIC FUNCTIONS OF THE SILVER–SILVER IODIDE, HYDROGEN IODIDE, HYDROGEN CELL IN WATER-METHANOL MEDIA. II. POLAROGRAPHIC STUDIES OF SOME COMPLEXES OF NEPTUNIUM (V) AND (VI). McIntyre, John Mark. Fayetteville, Ark., Univ. of Arkansas, 1968. 130p.

Thesis.

The electromotive force of the H_2 (1 atm) HI (m) AgI–Ag cell was determined in water, water–methanol, and methanol over a concentration range of 0.10 to 0.005 molal HI. Buffered systems previously used in this cell were excluded by using extreme care in designing equipment, and preparing and handling solvents and solutions. The standard potentials, free energies, enthalpies, and entropies were calculated and reported for the various solvent systems and temperatures. The mean ionic activity coefficients and the constants for the Debye-Huckel theory for the activity coefficients were obtained and reported. The data and calculated values are discussed and some explanations postulated. Chloride ion and adenosine triphosphate did not produce detectable shifts in the polarographic waves of Np ions, and perchlorate ion formed waves that were irreversible. EDTA, TEPA, and acetate ion formed stable complexes with Np, which gave reversible polarographic waves over certain pH ranges. All three complexes were found to obey the Ilkovic equation, which relates the diffusion currents to the concentrations of the metal ions. The composition of each complex was discussed. The acetate complex showed no hydrogen ion dependence for the half-wave potentials, while the other two complexes showed a linear pH dependence of the half-wave potential over certain pH ranges. TEPA formed a stable complex in a basic solution, while the other two formed stable complexes in acidic solutions. (Disser. Abstr.)

4601 KINETICS OF OXIDATION UNDER LOW OXYGEN PRESSURE OF PULVEROUS SAMPLES OF ZIRCONIUM AND TUNGSTEN MONOCARBIDES AND OF MOLYBDENUM HEMICARBIDE. DuFour, L.-Cl.; Simon, J. (Faculte des Sciences, Dijon, France). Bull. Soc. Chim. Fr., No. 9, 3643-51(Sept. 1968). (In French).

By oxidizing ZrC between 450 and 700°C ($1.10^{-3} < p_{O_2} = 100$ torr), three types of curves of advancement were observed depending on whether the elimination of carbon was instantaneous, slow, or infinitely slow. In the first case (high pressures), the oxidation, perturbed at first by the diffusion of oxygen in the carbide, became quickly linear ($E \sim 37$ kcal-mole^{-1}), the cubic zirconia formed being more and more porous. At the lowest pressures, carbon remained in the solid, but the internal interfacial processes maintained their own rate ($E \sim 45$ kcal-mole^{-1}). In the oxidation of WC between 500 and 650°C, and of Mo_2C between 440 and 520°C, carbon was quickly oxidized whereas the trioxide formed became porous; the transformation tended to occur at a constant rate with characteristics close to those found in the linear oxidation of the corresponding metals. (auth)

4602 PHYSICO-CHEMICAL STUDIES OF AMMONIUM PENTAFLUOXYURANATE. I. CRYSTALLINE STRUCTURE OF $(NH_4)_3UO_2F_5$. Nguyen-Quy-Dao (Faculte des Sciences, Paris). Bull. Soc. Chim. Fr., No. 9, 3542-6(Sept. 1968). (In French).

The preparation of monocrystals of ammonium dioxopentafluorouranate(VI) is reported together with some of its physicochemical properties. The crystal structure is described. It has a super-structure due to the fact that the uranium atoms are slightly displaced from their ideal position in a face-centered orthorhombic lattice. The $UO_2F_5^{3-}$ ion has a configuration of a slightly deformed pentagonal bipyramid. The structure is discussed and compared with that of analogous compounds. (auth)

4603 NOMOGRAM FOR DETERMINING EFFECTIVE (FOR GAMMA-RAYS) ATOMIC NUMBER OF COMPLEX COMPOSITION MEDIA. Pshenichnyi, G. A. At. Energ. (USSR), 25: 154-5(Aug. 1968). (In Russian).

For a multicomponent medium the calculation of an average value of the atomic number Z is a tedious process which can be simplified by selecting a reference element in the complex mixture. The contents of all the other elements in the mixture are converted to equivalent contents of the reference element by use of a nomogram. The total equivalent content of the reference element is summed up, and the average value of Z is obtained from the nomogram. As an example, it is desired to find the average Z value of a magnetic ore containing 50% Fe_2O_3, 30% FeO, 5% Al_2O_3, 8% SiO_2 and 5% CaO. The equivalent Fe contents are found to be 36, 24, 0.35, 0.65, and 1.5% respectively. The total iron content, which is equal to the sum of the equivalent contents, is 62.5%. The nomogram gives an average Z value of 22.3 for this iron content. (TTT)

4604 PROTACTINIUM. Scherff, Hans-Ludwig (Ispra Establishment of the European Communities' Research Centre, Italy). Euratom Rev., 7: 74-81(Sept. 1968).

Although ^{231}Pa was discovered by Fajans and Gohring in 1913 as a decay product of uranium, it was not until the latter nineteen-fifties that sufficient quantities of protactinium isotopes became available for broad chemical studies. Knowledge of the chemical and physical properties of protactinium, especially in the condensed phase, is of considerable interest in connection with the thorium breeding cycle. Problems presented by formation of ^{233}Pa in the thorium matrix in breeder reactors and methods for their control are discussed. (J.G.B.)

4605 INTERNATIONAL SYMPOSIUM ON MACROMOLECULAR CHEMISTRY, PRAGUE, AUGUST 30–SEPTEMBER 4, 1965. PART 6. Mark, H.; Overberger, C. G.; Fox, T. G. (eds.). J. Polym. Sci., Part C, No. 16, 3079-3638(1968). (CONF-650801).

Presentations are divided into four categories: mechanisms of the formation and transformations of macromolecular substances;

structure and properties of macromolecular compounds, their systems and models; compounds, which include inorganic and organic macromolecular compounds and systems; and methods, which include diffractometry, spectrometry, physicochemical optics, molecular hydrodynamics, thermodynamics, etc. Four papers have been abstracted separately for NSA. (J.G.B.)

For abstracts of individual papers see: 4663–4666.

4606 METHOD FOR THE OBTAINMENT OF URANIUM FLUORIDE. Delange, Maurice; Huet, Henri; Vertes, Paul (to Commissariat a l'Energie Atomique). U. S. Patent 3,403,986. Oct. 1, 1968. Priority date Apr. 20, 1960, France.

Uranium tetrafluoride is produced by continuously feeding granular UO_3 into the top of a vertical reaction vessel to travel through the vessel by gravity to the bottom reacting with a reducing gas stream passing countercurrent through the vessel, to yield UO_2, which passes through a cooling zone into the top of a second reaction vessel through which it passed downwardly while reacting with a stream of HF fed in at the bottom of the second reaction vessel. The gas stream from the top of the second reaction vessel is passed to the bottom end of the cooling zone, and the cooling zone maintained at 150 to 300°C is of sufficient length to ensure absorption of unreacted HF by the granular mass traveling through it from the first reaction vessel. The second reaction vessel is maintained at a temperature of 400 to 550°C. (B.L.M.)

4607 PART I. SECONDARY DEUTERIUM ISOTOPE EFFECTS FOR IONIZATION AND SOLVOLYSIS OF TRANS-α,γ-DIMETHYLALLYL p-NITROBENZOATE. PART II. SOLVOLYSIS OF cis-α,γ-DIMETHYLALLYL p-NITROBENZOATE IN AQUEOUS ACETONE. Holmes, David Alan. Madison, Wis., Univ. of Wisconsin, 1968. 170p.

Thesis.

Secondary deuterium isotope effects on rates of ionization and solvolysis of trans-α,γ-dimethylallyl p-nitrobenzoate in 90% aqueous acetone were examined. The secondary deuterium isotope effects for solvolysis (k_t) and loss of optical activity (k_α) of α,γ-dideuterio-trans-α,γ-dimethylallyl p-nitrobenzoate in 90% aqueous acetone at 99.6°C are 1.12 ± 0.01 and 1.10 ± 0.02. The isotope effect for racemization $[(k_\alpha - k_t)_H/(k_\alpha - k_t)_D]$ is 1.10 ± 0.03. For this dideuterated ester the isotope effect is the same for ionization (k_α) and racemization ($k_\alpha - k_t$) as for solvolysis (k_t) even though there is a large difference between these rates. The secondary deuterium isotope effect for solvolysis of the α- and γ-deuterated p-nitrobenzoates in 90% aqueous acetone at 99.6°C are 1.13 ± 0.01 and 1.00 ± 0.01. The former is consistent with the usual α-deuterium kinetic isotope effect of about 15% associated with an S_N1 solvolysis. The isotope effect for the γ-deuterated ester indicates that the greater electron-donating ability of deuterium compared to hydrogen is not a significant factor in deuterium effects on k_t. The secondary deuterium isotope effect for loss of optical activity of the α-deuterated ester is 1.16 ± 0.01 and γ-deuterated ester is 0.95 ± 0.02. The respective isotope effects on k_{rac} are 1.17 ± 0.02 and 0.95 ± 0.03. A strong case has not been made for a real difference between the deuterium isotope effects on solvolysis and loss of optical activity for the monodeuterated esters because of the possible uncertainty introduced by an unsymmetrical intermediate. It is interesting that the isotope effect for the γ-deuterated ester is consistent with the greater electron releasing inductive effect of D compared to H. The kinetics and stereochemistry of solvolysis of cis-α,γ-dimethylallyl p-nitrobenzoate in 80% aqueous acetone were investigated. (TSS) (Disser. Abstr.)

4608 STEPWISE FORMATION OF METAL CHELATES OF URANIUM(VI) AND THORIUM(IV) WITH AMMONIUM AURINTRICARBOXYLATE. Banerjee, A.; Dey, A. K. (Univ. of Allahabad, India). J. Inorg. Nucl. Chem., 30: 3134-9(Nov. 1968).

An investigation of Aluminon (AAC) chelates of uranium and thorium aimed at obtaining information on the stepwise stability constants of the various complexes, and also on the proton–ligand stability constants of AAC is reported. (TSS) (UK)

4609 ISOTOPE EFFECTS OF ELECTROMIGRATION IN MOLTEN LITHIUM–POTASSIUM SULFATE MIXTURES. Lunden, Arnold; Ljubimov, Vladislav (Chalmers Inst. of Tech., Goteburg). Z. Naturforsch., 23a: 1558-62(Oct. 1968).

The difference in mobility of the isotopes of lithium and potassium has been studied in molten sulfate mixtures over the concentration range 41 to 90 equiv % Li_2SO_4. For the eutectic composition (80% Li_2SO_4) the temperature range 625 to 835°C was covered. The mass effect, μ, (relative difference in mobility divided by relative difference in mass) was calculated. The accuracy, which is much lower for potassium than for lithium, was not sufficient to provide information on the temperature dependence of the mass effects, but it was evident that the ratio between the mass effects of the two cations depends upon concentration. Thus, while the mass effect for lithium is −0.13 ± 0.02 over the whole range, for potassium it is of the order of −0.16 for the eutectic concentration and −0.07 for the mixture with 41% Li_2SO_4. The observed increase of the mass effect at low concentrations is in agreement with results for other systems and can be expected from simple models of the transport mechanism. For lithium the mass effect is the same in the molten sulfate mixtures as in pure fcc lithium sulfate. (auth)

4610 STUDY AT HIGH TEMPERATURES OF THE SYSTEMS FORMED BY ZIRCONIUM OXIDE WITH THE SESQUIOXIDES OF SAMARIUM AND GADOLINIUM. Rouanet, Alain; Foex, Marc (Centre National de la Recherche Scientifique, Montlouis, France). Compt. Rend., Ser. C, 267: 873-6(Oct. 7, 1968). (In French).

A study of the systems zirconium oxide–samarium oxide and zirconium oxide–gadolinium oxide was carried out at very high temperature up to the melting point of the products. The proposed diagrams define, for various compositions, the thermal and structural characteristics of the phases below 1800°C. (tr-auth)

4611 ELECTRONIC ENERGY LEVELS IN THE TRIVALENT LANTHANIDE AQUO IONS. I. Pr^{3+}, Nd^{3+}, Pm^{3+}, Sm^{3+}, Dy^{3+}, Ho^{3+}, Er^{3+}, AND Tm^{3+}. Carnall, W. T.; Fields, P. R.; Rajnak, K. (Argonne National Lab., Ill.). J. Chem. Phys., 49: 4424-42 (Nov. 15, 1968).

The free-ion energy-level schemes of the Pr^{3+}, Nd^{3+}, Pm^{3+}, Sm^{3+}, Dy^{3+}, Ho^{3+}, Er^{3+}, and Tm^{3+} aquo ions were determined from their absorption spectra in dilute acid solution at 25°. Energy-level assignments were made by comparison with crystal spectra, and on the basis of correlations between calculated and observed band intensities. For most of the ions, it was possible to identify several transitions giving rise to bands at energies as high as 45,000 to 50,000 cm^{-1}. Sufficient numbers of assignments were made to justify inclusion of the effects of configuration interaction in the calculation of the energy-level parameters. Variation of the electrostatic, spin–orbit coupling, and configuration-interaction parameters across the lanthanide series is examined. (auth)

4612 ELECTRONIC ENERGY LEVELS OF THE TRIVALENT LANTHANIDE AQUO IONS. IV. Eu^{3+}. Carnall, W. T.; Fields, P. R.; Rajnak, K. (Argonne National Lab., Ill.). J. Chem. Phys., 49: 4450-5(Nov. 15, 1968).

The free-ion energy level scheme of Eu^{3+} (aquo) to ~40,000 cm^{-1} was determined from the absorption spectrum of Eu^{3+} in dilute acid solution at 25°. Energy-level assignments were made on the basis of correlations between calculated and observed intensities. A least-squares fit of 26 J levels, including the effects of configuration interaction, gave an rms deviation of 40 cm^{-1}. The parameter values were $E^1 = 5573.0$, $E^2 = 26.708$, $E^3 = 557.39$, $\zeta_{4f} = 1326.0$, $\alpha = 25.336$, $\beta = -580.25$, and $\gamma = 1155.7$. (auth)

4613 ELECTRONIC ENERGY LEVELS OF THE TRIVALENT LANTHANIDE AQUO IONS. III. Tb^{3+}. Carnall, W. T.; Fields, P. R.; Rajnak, K. (Argonne National Lab., Ill.). J. Chem. Phys., 49: 4447-9(Nov. 15, 1968).

A total of 23 experimental free-ion energy levels of Tb^{3+} (aquo) were fit with an rms deviation of 56 cm^{-1}. The resulting parameters are: $E^1 = 6021.5$, $E^2 = 29.030$, $E^3 = 608.54$, $\zeta_{4f} = 1709.5$, $\alpha = 20.131$, $\beta = -370.21$, and $\gamma = 1255.9$. The latter three parameters arise from including effects of configuration interaction in the calculation. Assignments were based upon a correlation between calculated and observed band intensities at energies up to ≈40,000 cm^{-1}. (auth)

4614 ELECTRONIC ENERGY LEVELS OF THE TRIVALENT LANTHANIDE AQUO IONS. II. Gd^{3+}. Carnall, W. T.; Fields, P. R.; Rajnak, K. (Argonne National Lab., Ill.). J. Chem. Phys., 49: 4443-6(Nov. 15, 1968).

The free-ion energy level scheme of Gd^{3+} (aquo) to ~52,000 cm^{-1} was determined from the absorption spectrum of Gd^{3+} in dilute acid solution at 25°C. Several new absorption bands near 50,000 cm^{-1} were ascribed to transitions from the ground state to components of the ^6G multiplet. Energy level assignments were made on the basis of correlations between calculated and observed intensities. The resulting parameters were: $E^1 = 5761$, $E^2 = 28.02$, $E^3 = 582.0$, $\zeta_{4f} = 1450$, $\alpha = 22.55$, $\beta = -103.7$, $\gamma = 997$. (auth)

4615 SPECTRAL INTENSITIES OF THE TRIVALENT LANTHANIDES AND ACTINIDES IN SOLUTION. II. Pm^{3+}, Sm^{3+}, Eu^{3+}, Gd^{3+}, Tb^{3+}, Dy^{3+}, AND Ho^{3+}. Carnall, W. T.; Fields, P. R.; Rajnak, K. (Argonne National Lab., Ill.). J. Chem. Phys., 49: 4412-23(Nov. 15, 1968).

The experimentally determined band intensities in the solution absorption spectra of the trivalent lanthanides were correlated

with a theoretical expression derived by Judd. The spectra were measured in a single medium, dilute acid solution, and, in most cases, in the range ≈6,000 to 50,000 cm^{-1}. In general, the correlation between calculated and observed intensities was very good, even at higher energies. The variation of the intensity parameters over the series is discussed as is the somewhat unexpected degree of correlation obtained in the ultraviolet region. (auth)

4616 REACTION OF PROTACTINIUM(V) PENTACHLORIDE WITH NITROSYL CHLORIDE. MacCordick, J. (Univ., Strasbourg. CRNS, Strasbourg). Inorg. Nucl. Chem. Lett., 4: 665-9(Nov. 1968).

It was found that in the presence of a large excess of NOCl protactinium pentachloride forms a stable ionic octachloro-compound of probable formula $(NO)_3PaCl_8$. Details are given of the preparation method for $^{231}PaCl_5$ and the nitrosyl compound, and also the method of analysis. The thermal behavior of the complex was also studied, together with Raman and gamma ray spectra. In color and solubility in liquid NOCl the compound resembles $NONbCl_6$ and $NOTaCl_6$, but it appears to have a more pronounced ionic character and is thermally more stable. (UK)

4617 A NOTE ON THE PREPARATION OF Th AND U OXY-CHALCOGENIDES. Boelsterli, H. U.; Hulliger, F. (Cyanamid European Research Inst., Geneva). J. Mater. Sci., 3: 664-5 (Nov. 1968).

It is stated that in attempts to grow single crystals of ternary Th and U chalcogenides (with Si, Ge, P, As, Sb, or Bi as third element) in hot uncoated silica tubes by a transport reaction, oxychalcogenides were obtained. Bromine or iodine was used as transport agent. In the case of Th, pseudohexagonal ThOS crystals were obtained. With Se, pseudohexagonal crystals of ThOSe were exceptions, truncated square pyramids predominating. ThOTe crystals were tetragonal. Pseudohexagonal needles of UOS were also obtained, and square platelets of UOTe. Attempts to synthesize USiS, USiSe, and USiTe from the elements resulted in microcrystalline UOS, UOSe, and UOTe, together with small Si crystals. In all these compounds the oxygen came from the quartz ampoule. The structure of these compounds is discussed. Magnetic measurements were made. (U.K.)

4618 CRYSTALLOGRAPHY OF URANYL DIETHYLDITHIO-CARBOMATE. IV. $UO_2[S_2CN(C_2H_5)_2]_2.HN(C_2H_5)_2$, OF MONOCLINIC A AND B PHASES. Bonatti, Stefano; Cioni, Claudio; Franzini, Marco; Troysi, Mirella. (CNR, Pisa, Italy). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 44: 427-34(Mar. 1968). (In Italian).

Studies were made on the reaction products between uranyl salts and Na-diethyldithiocarbamate. The results of the crystallographic and chemical study of two monoclinic polymorph crystalline phases are reported. On the basis of the chemical, x-ray, and i.r. data the formula $UO_2[S_2CN(C_2H_5)_2]_2 \cdot HN(C_2H_5)_2$ was assigned to the compound. (auth)

4619 INTERACTION OF BENZENE WITH PROTIUM AND DEUTERIUM ON COPPER–NICKEL FILMS WITH KNOWN SURFACE COMPOSITION. van der Plank, P.; Sachtler, W. M. H. (Rijksuniversiteit, Leiden). J. Catal., 12: 35-44(Sept. 1968).

Copper–nickel films were prepared by successively depositing the two metals from the vapor and subsequently sintering the films under ultra-high vacuum at 200°C. The nickel content of the film surfaces could be "titrated" by selective chemisorption of hydrogen. In agreement with expectation all films with overall compositions within the miscibility gap of the copper–nickel system at 200°C possess an equal surface composition of 23 ± 4 at. % of Ni. Benzene is hydrogenated at a constant rate at a given temperature over these films with equal surface composition, but widely varying overall composition. The activation energy over these alloys is E_{all} = 25 kcal/mole, while E_{Ni} = 12 kcal/mole. The rate of the exchange reactions between benzene and deuterium at 41°C is, again, constant for alloys of equal surface composition; it is by several orders of magnitude larger than the rate of hydrogenation at the same temperature. The exchange reaction displays a constant multiplicity over the alloys with equal surface composition. The totality of the results presented confirms the model proposed previously on the phase distribution of equilibrated copper–nickel films. (auth)

4620 SOLVOLYTIC α-DEUTERIUM EFFECTS FOR DIFFERENT LEAVING GROUPS. Shiner, V. J. Jr. (Indiana Univ., Bloomington); Rapp, M. W.; Halevi, E. A.; Wolfsberg, M. J. Amer. Chem. Soc., 90: 7171-2(Dec. 4, 1968).

It was previously reported that p-methylbenzyl-α-d_2 chloride shows nearly the same isotope rate effect at 25°C in 94% trifluoroethanol–water (1.146 per D) and 70% trifluoroethanol–water (1.140) as was reported for α-phenylethyl-α-d chloride at 25°C in various ethanol–water mixtures (1.146 to 1.153). This finding suggests that the α-deuterium effect for a limiting reaction is primarily a function of the leaving group and not of the structure of the particular alkyl group. With the use of methyl halide force fields and geometries, the equilibrium constant, K_{ex}, for $CH_3Cl + CH_2DBr \rightleftharpoons CH_2DCl + CH_3Br$ was calculated to be 1.037 at 25°C. Detailed calculations indicate that this isotope effect reflects mainly the fact that force constants involving H–C–halide bending motion are larger in chloride than in bromide. The kinetic isotope effect, R, was found to be essentially the same as K_{ex}, the equilibrium constant for isotopic exchange between the reactants. The near agreement between the experimental value of R and the calculated value of K_{ex} seems to indicate that the force constants in the transition states of these limiting solvolysis reactions depend much less strongly on the particular halide than do the force constants of the reactants. (D.H.M.)

4621 SECONDARY DEUTERIUM ISOTOPE EFFECTS ON THE TRANSFER OF TRIPLET ELECTRONIC EXCITATION TO AN OLEFIN. Caldwell, Richard A.; Sovocool, G. Wayne (Cornell Univ., Ithaca, N. Y.). J. Amer. Chem. Soc., 90: 7138-9 (Dec. 4, 1968).

Secondary deuterium isotope effects on the photosensitized trans–cis isomerization of β-methylstyrene were studied. Results are reported which illustrate that deuterium isotope effects can be useful mechanistic probes in studying energy–transfer mechanisms. The most significant result obtained was that the initially produced cis is richer in the unlabeled compound than is the starting material. Clearly there is an isotope effect in the "normal" direction, $k_H/k_D > 1$, on the photosensitized isomerization. (D.H.M.)

4622 KINETICS AND RATE CONSTANTS FOR THE REDUCTION OF ALKYL HALIDES BY ORGANOTIN HYDRIDES. Carlsson, D. J.; Ingold, K. U. (National Research Council of Canada, Ottawa). J. Amer. Chem. Soc., 90: 7047-55(Dec. 4, 1968).

The kinetics of the photochemically initiated reactions between some alkyl halides (chlorides, bromides, and iodides) and some triorganotin hydrides were examined in cyclohexane at 25°C. Chains are generally terminated by bimolecular radical–radical reactions. In general, with alkyl chlorides, the rate-controlling step for chain propagation involves chlorine abstraction by a triorganotin radical, while with bromides and methyl iodide, the rate-controlling step involves hydrogen abstraction from the hydride by the alkyl radicals. The deuterium kinetic isotope effect for this step, k_H/k_D, is about 3. Absolute rate constants were determined by the rotating-sector technique. Chain termination rate constants are near the diffusion-controlled limit for the self-reactions of both alkyl radicals and triorganotin radicals. Rate constants for halogen abstraction by tri-n-butyltin radicals vary from 8×10^2 M^{-1} sec^{-1} for 1-chloropentane to 2.5×10^9 M^{-1} sec^{-1} for methyl iodide. The rate constants for hydrogen abstraction from tri-n-butyltin hydride by a number of alkyl radicals are ~10^6 M^{-1} sec^{-1}. The evaluation of the rate constants for both propagation reactions and for two out of the three possible termination reactions means that these processes are now among the best understood two-step chain reactions. (auth)

4623 AROMATIC PROTONATION. V. SECONDARY HYDROGEN ISOTOPE EFFECTS ON HYDROGEN ION TRANSFER FROM THE HYDRONIUM ION. Kresge, A. J.; Onwood, D. P.; Slae, S. (Illinois Inst. of Tech., Chicago). Contract AT(11-1)-1025. J. Amer. Chem. Soc., 90: 6982-8(Dec. 4, 1968).

The effect of deuterium substitution in the nonreacting bonds of the hydronium ion on the rate of hydrogen ion transfer from this acid to an aromatic substrate was determined using a method which eliminates primary isotope effects. Measurements were carried out on two substrates, 1,3-dimethoxybenzene and 1,3,5-trimethoxybenzene, and, despite the fact that these substances react at rates which differ by 10^3, identical secondary isotope effects were found: $(k_H/k_D)_{sec} = 0.59 \pm 0.01$ at 25°C. This result implies that the magnitude of this isotope effect is not sensitive to changes in transition-state structure, at least over the range investigated. Possible reasons for this behavior are discussed. (auth)

4624 KINETICS AND MECHANISM OF NUCLEOPHILIC SUBSTITUTION IN NICKEL TETRACARBONYL. Day, J. Philip; Basolo, Fred; Pearson, Ralph G. (Northwestern Univ., Evanston, Ill.). J. Amer. Chem. Soc., 90: 6927-33(Dec. 4, 1968).

The rate of the substitution reaction of nickel carbonyl with triphenylphosphine or carbon monoxide was measured over a 30° temperature range, in solution in n-hexane and toluene (Ph_3P only), and in the gas phase (CO only). The reactions were followed by infrared spectrophotometry in the C–O stretching region, using $C^{18}O$ for the CO exchange reactions. The rates are independent of concentration or type of nucleophile, but first order with respect

to $Ni(CO)_4$ concentration. Rates of reaction in the gas phase or in toluene are ca. twice those in n-hexane, but activation parameters for all reactions are similar (ΔH^* from 22 to 24 kcal mol^{-1}, ΔS^* from +7 to +14 eu). In particular, and contrary to earlier results, CO and Ph_3P in the same solvent react with indistinguishable rates and activation parameters and compete for the same activated complex. (auth)

4625 HYDROGEN ISOTOPE EFFECT AND INTERMEDIATE IN OXYHYDROGEN REACTION ON ZnO. Sugimoto, Tadami; Horiguchi, Hiroyuki (Tokyo Univ.). Shokubai (Tokyo), 10: Suppl., 10-12(Mar. 1968). (In Japanese).

The mechanism of oxyhydrogen reaction on ZnO is divided in three phenomena: adsorption-dissociation of reactant gas on catalyst, surface reaction, and desorption of products. In ZnO(Al), ZnO, and Zn(Li) where the concentration of conductive ZnO electrons is changed, the H_2-D_2 exchange reaction is extremely rapid, even at 85°C where the oxyhydrogen reaction is slow, except for ZnO(Li). And, the temperature dependence of oxyhydrogen reaction is ZnO(Al) > ZnO > ZnO(Li). In measurement of hydrogen isotope effect above 120°C, H_2 reacts 1.4 to 2.0 times as rapidly as D_2, but below it no isotope effect is observed. This phenomenon cannot be explained by the vapor pressure ratio for H_2O and D_2O. From the experiment, surface reaction $H-O(S) + H-Zn(S) \rightarrow H_2O + Zn(S)$ at higher temperatures, and the adsorption-dissociation of O_2 at lower temperatures, is considered to be the control of rate of oxyhydrogen reaction. (NSA of Japan)

4626 TEMPERATURE AND CONCENTRATION DEPENDENCE OF THE INNER MOBILITY OF ^6Li AND ^7Li IN MOLTEN LiCl AND $LiNO_3$. Jordan, S.; Lenke, R.; Klemm, A. (Max-Planck-Institut fuer Chemie, Mainz). Z. Naturforsch., 23a: 1563-8(Oct. 1968). (In German).

The quotients of the specific electric conductivity of molten ^6LiCl and ^7LiCl as well as $^6LiNO_3$ and $^7LiNO_3$ were measured. Results are given for specific mass effect. The mobilities of ^6Li and ^7Li in molten LiCl were determined. (M.C.G.)

4627 n- AND π-PARTICIPATION AND SECONDARY DEUTERIUM ISOTOPE EFFECTS. Eliason, R.; Tomic, M.; Borcic, S.; Sunko, D. E. (Univ. of Zagreb). Chem. Commun., No. 23, 1490-1 (1968).

Measurements are reported on secondary α-deuterium isotope effects in unambiguous cases of n- and π-bond participation in ethanolysis reactions. The compounds 4-methoxy-1-pentyl p-bromobenzenesulphonate and 7-anti-norbornyl toluene-p-sulphonate were chosen for study. Results are discussed, and it is stated that extension of these studies to other systems is necessary before definite conclusions can be drawn regarding the usefulness of α-secondary isotope effects in the investigation of π and also σ participation. (UK)

4628 THE MAGNITUDE OF SECONDARY β-DEUTERIUM ISOTOPE EFFECTS IN CASES OF α-PARTICIPATION. Jerkunica, J. M.; Borcic, S.; Sunko, D. E. (Univ. of Zagreb). Chem. Commun., No. 23, 1488-9(1968).

Evidence is presented on the usefulness of the secondary β-deuterium isotope effect as a probe for "neighbouring group participation" in solvolysis reactions. The compounds studied were substituted exo-norborn-2-yl derivatives and the corresponding 2-endo-epimers. Results are tabulated and discussed for isobornyl, bornyl, and 2-methylnorbornyl derivatives. An essentially identical β-effect magnitude was found for all endo-derivatives. In the exo-series the rate retardations varied with the degree and site of substitution. (UK)

4629 VIBRONIC AUTOIONIZATION AND PREDISSOCIATION IN HYDROGEN. Nielsen, S. E. (Univ. of Copenhagen); Berry, R. S. Chem. Phys. Lett., 2: 503-6(Nov. 1968).

A theoretical treatment which accounts for the phenomena reported in recent high-resolution photoionization experiments on H_2, HD, and D_2 is presented. The effect of isotopic substitution on the autoionization and predissociation rates is also derived. In addition, the method is applied to associative ionization and dissociative recombination. (D.H.M.)

4630 NUCLEAR MAGNETIC RESONANCE SHIFTS OF PARAMAGNETIC ORGANOMETALLIC ACTINIDE COMPLEXES. I. ^1H-NMR STUDIES OF URANIUM(IV) TETRACYCLOPENTADIENIDE. Von Ammon, R. (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.); Kanellakopulos, B.; Fischer, R. D. Chem. Phys. Lett., 2: 513-15(Nov. 1968).

The isotropic ^1H-NMR shift of the tetrahedral uranium(IV)tetracyclopentadienide complex was obtained and the mechanism of the transferred hyperfine interaction between the 5f electrons and the ligands is discussed. (auth)

4631 DIPHTHALOCYANINATO-THORIUM(IV) AND URANIUM(IV). Lux, F.; Dempf, D.; Graw, D. (Technische Hochschule, Munich). Angew. Chem. Int. Ed. Engl., 7: 819-20(Oct. 1968).

Thorium tetraiodide was treated with phthalodinitrile at 240°C. After extraction of the excess of nitrile, sublimation at 550°C/10^{-5} torr, which involved evolution of iodine, yielded dark violet crystals of diphthalocyaninatothorium(IV). Dark violet diphthalocyaninatouranium(IV) was formed analogously from UI_4 and phthalodinitrile. These products are very stable thermally and resistant to air. The Th compound can be sublimed at 600°C in a N_2 stream at atmospheric pressure with formation of needle-shaped crystals. Both compounds are soluble in pyridine, quinoline, 1,2,4-trichlorobenzene, 1-chloronaphthalene, and the hexamethyltriamide of phosphoric acid. Neither compound can be recrystallized from concentrated sulfuric acid. Spectral characteristics of the compounds are also given. (P.C.H.)

4632 SYNTHESIS OF CERTAIN UREA-CONTAINING THORIUM COMPOUNDS IN THE ABSENCE OF SOLVENT. Molodkin, A. K.; Ivanova, O. M.; Kozina, L. E. Zh. Neorg. Khim., 13: 2308-9(Aug. 1968). (In Russian).

Complex compounds of Th, containing from 2 to 11 coordinated molecules of urea, were synthesized in the absence of solvent. The compounds reacted with urea were $Th(NO_3)_4$, $ThCl_4$, $ThBr_4$, $Th(C_2O_4)_2$, and $Th(SO_4)_2$. (P.C.H.)

4633 REACTIONS OF Ta AND Nb PENTACHLORIDES WITH LEAD CHLORIDE. Chikanov, N. D. Zh. Neorg. Khim., 13: 2307-8(Aug. 1968). (In Russian).

Studies were made on the reactions of Ta and Nb pentachlorides with lead chloride by differential thermal analysis accompanied by visual observations. The temperature of the peritectic transformation for $Pb[TaCl_7]$ was −292°C and for $Pb[NbCl_7]$ it was −242°C. The eutectics that were formed by $TaCl_5$ with $Pb[TaCl_7]$ and by $NbCl_5$ with $Pb[NbCl_7]$ were close according to the composition and to the temperature of crystallization of pure pentachloride, respectively. In the ternary $TaCl_5-NbCl_5-PbCl_2$ system, the cross section for $Pb[TaCl_7]-Pb[NbCl_7]$ was studied. Analysis of the thermograms showed that the compounds $Pb[TaCl_7]$ and $Pb[NbCl_7]$ form a continuous order of solid solutions upon combined crystallization. (tr-auth)

4634 STUDIES ON PHASE EQUILIBRIUM IN THE SYSTEM $La_2O_3-UO_3-H_2O$ AT 270°C. Zubova, N. V.; Makarov, V. M.; Nikol'skii, V. D.; Petrov, P. N.; Teterin, E. G.; Chebotarev, N. T. Zh. Neorg. Khim., 13: 2284-9(Aug. 1968). (In Russian).

Compounds synthesized in the system $La_2O_3-UO_3-H_2O$ at 270°C were found to have the composition $La_2O_3 \cdot 4UO_3 \cdot 4H_2O$ and $La_2O_3 \cdot 2UO_3 \cdot 2.6H_2O$. The compounds were thermally unstable and decomposed upon dehydration. The compound $La_2O_3 \cdot 4UO_3 \cdot 4H_2O$ has a hexagonal structure with cell dimensions a = 6.878 ± 0.003 and c = 6.871 ± 0.003 Å. Thermal decomposition of the compounds at 1050°C led to the formation of solid solutions of uranium and lanthanum oxides with cubic lattice of the CaF_2-type. (tr-auth)

4635 TYPES OF TETRAVALENT PLUTONIUM IN OXALATE SOLUTIONS. Matyukha, V. A.; Krot, N. N.; Gel'man, A. D. Zh. Neorg. Khim., 13: 2124-7(Aug. 1968). (In Russian).

The solubility of sodium oxalate was determined in solutions of $K_4Pu(C_2O_4)_2$ and $K_4[Fe(CN)_6]$ at 25°C. It was found that in saturated solutions of $Na_2C_2O_4$ (concentration 0.35 to 40 mole) $Pu(C_2O_4)^{4-}$ does not have a noticeable tendency to attach itself to $C_2O_4^{2-}$ ions to form the complex anion $Pu(C_2O_4)_5^{6-}$. Therefore, it was concluded that Pu(IV) in oxalate solutions is in the form of the oxalate complex ion. (tr-auth)

4636 SYNTHESIS OF THORIUM OXALATE COMPOUNDS. Molodkin, A. K.; Balakaeva, T. A.; Kuchumova, A. N. Zh. Neorg. Khim., 13: 2117-23(Aug. 1968). (In Russian).

The following oxalate compounds of Th were synthesized: $Th(C_2O_4)_2 \cdot 6H_2O$; $H_2Th_2(C_2O_4)_5 \cdot 9H_2O$; $K_4Th(C_2O_4)_4 \cdot 4H_2O$; $Na_4Th(C_2O_4)_4 \cdot 6H_2O$; $[C(NH_2)_3]_4Th(C_2O_4)_4 \cdot 2H_2O$; $[C(NH_2)_3]_4Th(C_2O_4)_4 \cdot 3H_2O$; $(NH_4)_8Th(C_2O_4)_4 \cdot nH_2O$ (n = 6, 5, or 3); $(NH_4)_6Th(C_2O_4)_5 \cdot nH_2O$ (n = 7.5 or 3); $[Co(NH_3)_6]_2Th(C_2O_4)_5 \cdot 3H_2O$; $[C(NH_2)_3]_8(NH_4)_{12}Th_2(C_2O_4)_{15} \cdot 9H_2O$. Studies were made on certain properties of the oxalate compounds of thorium, such as molecular electric conductivity of aqueous solutions, refractive indexes, and densities. Molecular electric conductivity and substitution reactions indicated the complex character of thorium oxalates. (tr-auth)

4637 THORIUM NITRATE COMPLEXES. Golub, A. M.; Kalibabchuk, V. A.; Boiko, K. M. Zh. Neorg. Khim., 13: 2111-16(Aug. 1968). (In Russian).

The reactions of $ThCl_4$ with sodium nitrite in methanol and dimethylformamide (DMF) were studied conductometrically,

spectrophotometrically, and polarographically. The existence of nitrite complexes of thorium, containing from 1 to 4 nitro groups, was established. The equilibrium constants of reactions for the formation of thorium nitrite complexes were calculated according to polarographic data and showed that their stability increased upon going from DMF to methanol. The coordination compound $Th(NO_2)_4 \cdot 4DMF$ was isolated in the crystalline form and its solubility in different solvents was studied. It was thermographically established that $Th(NO_2)_4$ 4DMF is decomposed at 224°C with the separation of DMF and is melted at 265°C. It was confirmed by ir spectra that nitro groups are coordinated around Th through the oxygen atom. (tr-auth)

4638 STABILITY OF RARE EARTH COMPLEX COMPOUNDS WITH METHYLTHYMOL BLUE. Mal'kova, T. V.; Fateeva, N. A. Zh. Neorg. Khim., 13: 2094-2101(Aug. 1968). (In Russian).

In the systems of rare earth ions (Nd^{3+}, Sm^{3+}, Gd^{3+}, Ho^{3+}, Er^{3+}) with methylthymol blue, the equilibrium constants of mono- and dicoordination were calculated according to the metal of the complex compounds. The number of hydrogen ions that were isolated according to the first and second stages of the equilibrium of formation of these complexes were determined. The formulas assumed for the complexes are LnH_2Ind^- and $Ln_2H_2Ind(OH)_2$. (P.C.H.)

4639 REDUCTION OF URANIUM VAPOR BY CERTAIN METALS. Khripin, L. A.; Luk'yanova, L. A. Zh. Neorg. Khim., 13: 2047-9(Aug. 1968). (In Russian).

Two methods described in the literature for obtaining uranium trifluoride by the reduction of UF_4 by metals at high temperatures are discussed. In one case, liquid UF_4 is restored by U. The purity of UF_3 obtained by this method was varied from 60 to 98% UF_3. In the other method, solid uranium was interacted with melted Al. A product that contained about 90% UF_3 was obtained in this method. The use of very pure U is stressed for these methods, since all the impurities end up in the trifluoride. (tr-auth)

4640 HIGH TEMPERATURE REACTION RATE DATA. NO. 1. CRITICAL EVALUATION OF RATE DATA FOR HOMOGENEOUS, GAS-PHASE REACTIONS OF INTEREST IN HIGH-TEMPERATURE SYSTEMS. Baulch, D. L.; Drysdale, D. D.; Lloyd, A. C. Leeds, Eng., Univ. of Leeds, 1968. 25p.

Data are given for the following reactions: $CO + OH = CO_2 + H$; $CO + OD = CO_2 + D$; $CO + O = CO_2 + h\nu$; $CO + O = CO_2$; $CO + O + M$ (third body) $= CO_2 + M$; $CO_2 + H = CO + OH$; $CO_2 + O = CO + O_2$; $CO_2 + M = CO + O + M$. (UK)

4641 APPLICATION OF A QUANTITATIVE METHOD OF DIFFERENTIAL THERMAL ANALYSIS FOR THE DETERMINATION OF THE ENTHALPHY OF FORMATION OF U_3P_4 AND UP_2. Dogu, A.; Val, C.; Accary, A. (Service de Chimie des Solides, Gif sur Yvette, France). J. Nucl. Mater., 28: 271-9(1968). (In French).

A method of differential thermal analysis is described, which was used to determine, from measurements of ΔH for the compound UP, values of ΔH for U_3P_4 and UP_2. The method was made quantitative by means of preliminary calibration and by statistical analysis of the results. Although none of the cited compounds could be studied in the pure state, the proportion of each was determined by means of x-ray diffraction analysis. The following results were obtained: $\Delta H^0_T(U_3P_4)_{(red\ P)} = -266{,}000 \pm 23{,}000 + (12 \pm 0.5)T + 21.2 \times 10^{-3}T^2 - 3.5 \times 10^5T^{-1}$, (298°K < T < 800°K) $\Delta H^0_{298}(U_3P_4)_{(white\ P)} = -266 \pm 25$ kcal/mole; $\Delta H^0_T(UP_2)_{(red\ P)} = -91{,}500 \pm 11{,}100 - (4.9 \pm 1)T + 8.4 \times 10^{-3}T^2 - 1.2 \times 10^5T^{-1}$, (298°K < T < 800°K); and $\Delta H^0_{298\ white\ P)} = 100 \pm 12$ kcal/mole. The margin of error of about 10% could be reduced by increasing the number of measurements. (auth)

4642 SOLID STATE PREPARATION OF URANIUM MONOPHOSPHIDE. Driscoll, J. L.; Evans, P. E. (Univ. of Manchester, Eng.). J. Nucl. Mater., 28: 311-15(1968).

The preparation of uranium monophosphide (a potential nuclear fuel material) by the solid-state (nonexothermic) reaction of uranium and phosphorus below 400°C is shown to be feasible. Lattice parameter values determined by computer analysis show the UP and UO_2, present as an impurity, to be stoichiometric. The advantages of this preparation method compared with other methods are discussed. (auth)

Radiation and Nuclear Chemistry

Refer also to abstracts 4605 and 5488.

4643 (BARC-348) HOT ATOM CHEMISTRY: ANNEALING OF RECOIL DAMAGE AND SOLID STATE ISOTOPIC EXCHANGE IN COBALT COMPLEXES. Shankar, Jagdish (Bhabha Atomic Research Centre, Bombay (India)). 1968. 18p. Dep.

When cobalt complexes in the solid state are bombarded with thermal neutrons and subsequently analyzed, it was found that the bulk of the activity produced is Co^{2+}, or species that yield Co^{2+} during the separation process, while the rest of the activity is in the form of the original complex. It was also established that heating solid complexes after neutron bombardment results in an increase of retention. It was shown that solid-state isotopic exchange also occurs in complexes of the octahedral type. (M.C.G.)

4644 (COO-38-621) THESAURUS FOR RADIATION CHEMISTRY. Preliminary Edition. (Notre Dame Univ., Ind. Radiation Lab.). May 1968. Contract AT(11-1)-38. 44p. Dep. CFSTI.

The Radiation Chemistry Data Center has undertaken the collection and indexing of literature on radiation chemistry in order to facilitate the preparation of bibliographies and selection of papers for topics to be reviewed. A list of keywords that was developed for describing the papers is reported. The keyword list is followed by a formula list; a few species are indexed by their formula instead of name. The preliminary edition of the thesaurus serves as a guide in the selection of keywords for indexing the papers; new words are added frequently. Revised editions will be made available periodically. (auth)

4645 (COO-1385-22) SOME EFFECTS OF CRYSTAL STRUCTURE ON PRODUCTION OF RADICALS IN IRRADIATED CRYSTALS. Rogers, Max T.; Kispert, L. D. (Michigan State Univ., East Lansing. Dept. of Chemistry). Jan. 5, 1968. Contract AT(11-1)-1385. 12p. (CONF-680827-1). Dep. CFSTI.

From Conference on Radiation Chemistry, Lemont, Ill.

A series of anhydrous and hydrated polycrystalline metal acetates have been irradiated at 77°K with 1 MeV electrons and the ESR spectra observed. The principal stable free radical found in the hydrated materials was methyl whereas other species predominate in the anhydrous acetates and methyl radical was not observed. The absolute yield of methyl radicals, as well as the ratio of methyl to other species, appeared to increase with the number of molecules of water of hydration. The radicals obtained by breaking C–C bonds are also found in irradiated acetamide and it appears that such species may be favored in crystals whose structures are largely determined by hydrogen bonding. (auth)

4646 ON THE CHEMICAL FORMS OF ^{14}C PRODUCED BY THE REACTION OF $^{14}N(n,p)^{14}C$ IN METALLIC NITRIDES. II. BARIUM, GALLIUM, TITANIUM, VANADIUM, NIOBIUM, AND MOLYBDENUM NITRIDES. Kuhry, J.-C.; Adloff, J.-P. (Centre de Recherches Nucleaires, Strasbourg). Bull. Soc. Chim. Fr., No. 9, 3524-8(Sept. 1968). (In French).

The chemical forms of ^{14}C produced by pile irradiation of the nitrides Ba_3N_2, GaN, TiN, VN, NbN, and MoN, have been detected after dissolution of the samples or selective oxidation in the solid state. The ^{14}C activity is distributed among four forms: carbide, cyanide, cyanamide, and isocyanate. The first two are primary species which result from hot replacement collisions in the target; with increasing radiation doses cyanide is gradually changed into cyanamide and, in the presence of oxygen, into isocyanate. The labeled methane yield is correlated with the collision cross section of ^{14}C with a nitrogen or metal atom of the lattice. (auth)

4647 GAMMA RADIOLYSIS OF ETHYLENE AT HIGH TEMPERATURE. Castello, Gianrico (Univ., Genoa). Ann. Chim. (Rome), 58: 742-55(July 1968). (In Italian).

Technical-quality ethylene, with a purity of 99%, was γ irradiated at temperatures varying from 30 to 350°C at a pressure of 20 to 90 atm to doses up to 4.55×10^{20} eV/g (dose rate 900 R/min). The composition of the product at various temperatures was determined. Irradiation of ethylene at high temperature caused the yield to increase in comparison with the thermal yield at the same temperature. Below 150°C, $G(-C_2H_4)$ was constant over a wide dose range after an initial induction period, due to impurities. Above 150°C the $G(-C_2H_4)$ sharply increased. The composition of radiolysis products depended on dose and temperature. From analysis of reaction products, it was deduced that the polymerization is due to chain reaction of primary radicals with ethylene, and that the light radiolysis products are formed by ionic and molecular reactions. (BBB)

4648 STRUCTURE AND REACTIVITY OF TRANSITION-METAL COMPLEXES WITH POLYATOMIC LIGANDS. PART VII. INFRARED AND ELECTRON SPIN RESONANCE STUDIES OF THE EFFECT OF IRRADIATION ON HEXACYANOFERRATE(II) COMPLEXES IN ALKALI-METAL HALIDE MATRICES: EVIDENCE FOR THE FORMATION OF AN IRON(I) COMPLEX. Root, K. D. J.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A, No. 10, 2366-70(1968).

Infrared and ESR spectra of γ- and ultraviolet-irradiated hexacyanoferrate(II) ions in alkali metal halide matrices are reported. New infrared bands around 1950 cm^{-1} are attributed to an Fe(I) complex. This is supported by the depression of the F-band in the γ-irradiated samples containing the complex compared with those of pure halide samples. The ESR spectra are also compatible with an Fe(I) complex, but show evidence for a novel distortion, hyperfine structure from only one nitrogen atom being observed. Possible mechanisms for the distortion are discussed. (auth) (UK)

4649 STRONG-ACID MEMBRANE PREPARED FROM VINYL-ACETATE-GRAFTED POLYETHYLENE. Kawabe, Hiroshi; Yanagita, Masaya. Sci. Pap. Inst. Phys. Chem. Res. (Tokyo), 62: 81-90(June 1968).

A strong-acid membrane has been prepared by grafting vinyl acetate onto polyethylene (PE) powder, melt-pressing it to film, treating the film with an alkaline solution and succeedingly with 30% fuming sulphuric acid (Type IV). The film, made of irradiated PE powder in vacuo, and treated with latter reagent was also finished to a membrane (Type II). The facts that the ion exchange capacity of the Type IV membrane exceeds the one expected from the acetyl content and that PE is also reactive against the reagent suggest that PE matrix is sulfonated. The elementary analysis and titration curve of these reaction products showed the presence of some weak-acid groups containing O and some inactive groups containing S. The membrane of Type II is inferior to Type IV in electrochemical and mechanical properties. The properties of the membrane of Type IV in K-form to be of practical use are: dry capacity of 2 meq/g, weight swelling 40 to 50%, conductivity 2 to 4×10^{-3} Ω^{-1} cm^{-1}, $\bar{t}_+$ 0.98 ~ 1.00 (0.075 N), tensile strength 50 ~ 57 kg/cm^2, and elongation 80 to 100%. (auth)

4650 RADIOLYSIS OF VARIOUS STYRENE AND VINYLTOLUENE COPOLYMERS. Braginskii, R. P.; Karpov, V. L.; Leshchenko, S. S.; Finkel, E. E.; Chernova, I. K. Khim. Vys. Energ., 2: 472-3(Sept.-Oct. 1968). (In Russian).

Radioprotective effects of aromatic grouping of styrene and vinyltoluene copolymers with various monomers were studied. Polystyrene, styrene–acrylonitrile (24%) copolymer, styrene–α–methylstyrene (30%) copolymer, and styrene–methyl methacrylate (70%) copolymer, polyvinyl toluene, and vinyltoluene–acrylonitrile copolymer (28%) were irradiated in a vacuum by ^{60}Co γ rays with various doses. Tabulated data on gel fraction content and ratio of destruction and crosslinking (β/α) showed that radiochemical processes in styrene copolymers depend on the structure and the content of the comonomer. (R.V.J.)

4651 EPR SPECTRA AND SPATIAL DISTRIBUTION OF MACRORADICALS IN γ-IRRADIATED POLYCAPROLACTAM. Taranukha, O. M.; Vonsyatskii, V. A.; Lebedev, Ya. S. (Inst. of Chemistry of High-Molecular Compounds, Moscow. Inst. of Chemical Physics, Moscow). Khim. Vys. Energ., 2: 476-8(Sept.–Oct. 1968). (In Russian).

The EPR method was used for measuring the local concentrations of paramagnetic centers and to evaluate the irregularities in the space distribution of radicals formed in a polycaprolactam specimen irradiated by γ rays with 6 to 500 MRAD at 77°K. Graphical data obtained show that in γ-irradiated polycaprolactam, as in some other low-molecular-weight systems, the spatial distribution of stabilized free radicals is nonuniform but the local and mean concentrations vary similarly with dose increase, i.e., that the radicals concentrate in certain sections of the specimen. (R.V.J.)

4652 METHOD FOR EMULSION-POLYMERIZING FLUOROOLEFINS. Yonetani, Yuzuru (to Daikin Kogyo Co., Ltd.). Japanese Patent 1968-12817. May 30, 1968. Filed Dec. 27, 1963.

A method is proposed for obtaining a polymer-dispersed liquid of high density in a short period. The extreme smallness of polymer particles results in the high mechanical stability. In emulsion polymerization of a fluoroolefin in an aqueous media in the presence of a dispersing agent of the highly fluorinated alkyl systems, a hydrocarbon, which takes a liquid form under polymerization conditions, is added to the aqueous media, and the mixture is irradiated with ionizing radiation at the initial stage of reaction. Subsequently, the emulsion polymerization is allowed to proceed without irradiation. (NSA of Japan)

4653 METHOD FOR GIVING A QUALITY IMPROVEMENT TO POLYMER MOLDINGS IN A CONTINUOUS MANNER. Sagane, Norio (to Sekisui Chemical Co., Ltd.). Japanese Patent 1968-13047. June 3, 1968. Filed July 27, 1964.

A method is proposed to improve the quality of polymer moldings such as film, string, fiber, etc., by graft-copolymerizing a monomer on the molding by ionizing radiation. The molding is immersed in a copolymerizable monomer to infiltrate it into the molding. Then, the monomer-containing molding is passed through the monomer of the liquid phase and the monomer of the gas phase alternately a plurality of times; and while the monomer is in the gas phase, it is irradiated with ionizing radiation. (NSA of Japan)

4654 CHARGE PRODUCTION BY ULTRA VIOLET LIGHT AND X-RAYS IN ANTHRACENE AND TETRACENE SINGLE CRYSTALS. Turiel, Isaac. New York, New York Univ., 1968. 117p.

Thesis.

A method, which facilitates investigation of the effects of light or high-energy radiation after removal of the radiation and external field, was used to study charge production, localization, and recombination under light and x-ray irradiation in anthracene and tetracene. For this investigation, the crystal under investigation was sandwiched between an electrode and a thin insulating barrier such as mylar. Therefore only transient currents flow and high electric fields can be applied without danger of breakdown. Under light irradiation in thin crystals, the ratio of the positive to negative photocurrents, λ^+/λ^- was much larger when the illumination was through the electrode than when it was through the barrier; for thick crystals (1mm) λ^+/λ^- was the same for illumination through the barrier and electrode respectively; for thin crystals the "negative" current from the barrier, λ_{β^-}, was about ⅓ the magnitude of the positive current from the electrode; λ_{β^-} decreased with increasing crystal thickness and decreased markedly when the opposite electrode was replaced by a barrier; all the photocurrents except for the positive current from the barrier were linear with light intensity. It was concluded from the experimental results that λ_{β^-} was really a hole current from the unilluminated electrode and that it is not due to light reaching the crystal-electrode interface. Therefore it was assumed that λ_{β^-} was due to excitation energy traveling through the crystal to the electrode. At the electrode this "exciton" can give an electron to the electrode leaving a hole in the crystal. Further experiments were done to determine if this "exciton" might be a triplet exciton which has a lifetime of about 10^{-2} seconds. These experiments indicated that all the photocurrents reached their maximum values in the same amount of time ($\sim 5 \times 10^{-6}$ sec) after initiation of a 3 μsec light flash. Therefore it was assumed that λ_{β^-} was due to another excited state which can travel very quickly (10^{-6} sec) through a thin crystal and which has a short lifetime, or that the velocity of the triplet exciton is much greater than previously supposed. It was determined from polarization experiments (where charges are accumulated at the crystal-barrier interface) that trapping is negligible in these experiments. Less than 1% of the charge passing through the crystal is trapped in the bulk. Under x-ray irradiation the induced current was linear with electric field strength over a large range of electric field strengths and saturated at field strengths above 10^4V/cm; it was proportional to the intensity of irradiation; its magnitude decreased with the thickness of the sample for the same field strength and x-ray intensity, unlike the behavior of normal conduction; 1500 eV were required to produce one charge pair in anthracene, and 400 eV in tetracene; the saturation field strength was independent of the x-ray intensity (the intensity was varied by a factor of 10). From these results it was concluded that at the low x-ray intensities applied, recombination only occurs between the electron and hole from which it was separated. Bimolecular recombination between charges originating in different tracks and even for different changes in the same track is negligible under the conditions of these experiments. The x-ray- and light-induced currents were strongly reduced after thick crystals (1mm or greater) were irradiated with a large dose of x-rays (8×10^5 ergs absorbed). In addition, the saturation field strength of the x-ray induced current is increased and the x-ray current becomes sublinear with x-ray intensity. A large irradiation apparently produces trapping sites in the bulk of the crystal, which trap charges and thus produce some bimolecular recombination. (Disser. Abstr.)

4655 RADIATION SYNTHESIS CHEMICAL REACTIONS: ON THE EDC RADIATION-CHLORINATION FACILITY. Muramatsu, Takio (Ebara Mfg. Co., Ltd.). Ebara Jiho, 16: No. 63, 118-22(Sept. 1967). (In Japanese).

The EDC (ethylene dichloride) radiation-chlorination facility, delivered to the JAERI Takasaki Research Establishment, is described. Some features of the facility are as follows: reaction temperature −25 to +85°C; liquid material speed 10 to 70 ml/min; Cl_2 gas speed 5 to 20 l/min; reaction heat 300 to 1500 kcal/hr; radiation dose rate 5×10^4 to 5×10^5 RAD/hr; and one to several ^{60}Co rods, inserted in the middle of the reaction vessel. The typical G-value will have a peak in the vicinity of 1×10^5 RAD/hr, or about 10^5; with the increasing chlorine number, this value tends to move to the larger doses. (NSA of Japan)

4656 PROCESS FOR PREPARING AMIDES USING HIGH ENERGY IONIZING RADIATION. Stevens, Donald R.; Templin, Philip R. (to Gulf Research and Development Co.). U. S. Patent 3,400,064. Sept. 3, 1968. Filed Dec. 22, 1964.

A process for preparing an amide comprises subjecting an adduct composed of urea or thoiurea and a hydrocarbon to high-energy ionizing radiation at a temperature of about 10 to 150°C until at least 10 MRad of radiation are absorbed and then decomposing the irradiated adduct to remove unreacted urea or thiourea. (B.L.M.)

4657 METHOD FOR PRODUCING A CATION POLYMERIZATION CATALYZER OF MALEIC ACID ANHYDRIDE AND ETHER BY RADIATION IRRADIATION. Okamura, Seizo (to Japan Atomic Energy Research Inst.). Japanese Patent 1968-11096. May 10, 1968. Filed Oct. 15, 1964.

The cation polymerization catalyzer, obtained by the method, has a high polymerization power and can be stored with no change for a long period; the process of polymerization with the catalyzer is very simple. A mixture of maleic acid anhydride and ether is irradiated with ionizing radiation, to obtain the catalyzer having a cation-polymerization initiating power. (NSA of Japan)

4658 METHOD FOR PRODUCING FLUORINE-CONTAINING POLYKETONE. Tabata, Yoneho. Japanese Patent 1967-19251. Sept. 29, 1967. Filed July 29, 1963.

A mixture of tetrafluoroethylene and CO, either in gas-liquid phases, is irradiated with ionizing radiation to achieve the copolymerization. A high yield of polyketone having superior thermal and chemical resistances and obtainable in various qualities is produced. (NSA of Japan)

4659 STUDY OF THE MECHANISM OF FORMATION OF HYDROCARBON CONTAMINANTS ON OBJECTIVES IRRADIATED BY ELECTRONS. Zhdanov, Gl. S.; Vertsner, V. N. Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 1091-4(June 1968). (In Russian).

It is known that surfaces subjected to electron or ion bombardment become covered with a polymerized hydrocarbon. On calculating the rate of contamination of an objective in an electron microscope, it was previously assumed that the hydrocarbon contaminant reaching the target originates from the gas phase. However, it is shown that with a small size of the irradiated section of a sample it is necessary to take into account the surface diffusion of hydrocarbon molecules that can lead to an increase in the rate of contamination of an objective by more than two orders of magnitude. Thus by taking into account the surface diffusion it is possible to explain satisfactorily the rate of formation of hydrocarbon contaminants measured under different conditions of irradiation. The coefficient of surface diffusion was found to be $D_s \approx 2 \times 10^{-8}$ cm^2 sec^{-1}. The average lifetime of the molecules was about 1 sec at room temperature. (TTT)

4660 RADIATION-INDUCED REACTIONS WITH CELLULOSE. VI. COPOLYMERIZATION STUDIES WITH MONOMERS IN WETTING SOLVENTS. Dilli, S.; Garnett, J. L. (Univ. of New South Wales, Kensington, Australia). Aust. J. Chem., 21: 1827-33(July 1968).

Spent-fuel or ^{60}Co γ-induced grafting of monomers to cellulose was studied, using the wetting solvents dioxan, dimethylformamide, n-butylamine, acetone, and the primary alcohols methanol, ethanol, 1-propanol, and 1-butanol. Most data concern the monomer styrene but results for methyl methacrylate, vinyl acetate, 2- and 4-vinylpyridines are also presented. Styrene and methyl methacrylate in both air and vacuum readily grafted to cellulose in acetone, dioxan, and dimethylformamide as solvents, whereas vinyl acetate under similar conditions exhibited poor copolymerization behavior. All 3 monomers did not readily graft in a n-butylamine. The grafting properties of styrene in ethanol and 1-propanol were similar to those observed in methanol, whereas poor copolymerization is obtained in 1-butanol. Grafting yields for a variety of conditions with styrene-butanol solutions were generally low, and showed a considerable dependence upon the dose rate and the presence of oxygen. This sensitivity was lost at higher radiation doses. The dependence on dose rate can be explained, in combination with the higher value of $G_{radicals}$ for butanol, as termination by solvent radicals of the grafted chains. (BBB)

4661 EFFECT OF X-RAYS ON THE AUTOHYDROLYSIS OF ETHYLENE GLYCOL MONOACETATE. Wai, Nganshou; Lin, Mike Bull. Inst. Chem., Acad. Sinica, No. 15, 82-4(Sept. 1968).

The addition of 2N NaOH solution to ethylene glycol monoacetate did not allow the hydrolysis at 25°C to proceed very rapidly and the successive changes in pH value of the solution could be measured during 5 hours. When the solution was irradiated for 3 minutes by x rays at a dose rate of 25 roentgens per ml, the velocity of hydrolysis was higher than in the case without irradiation. (auth)

4662 GAMMA RADIATION EFFECTS ON CATALYTIC PROPERTIES OF La_2O_3 AND CeO_2 IN $^{16}O_2 + {}^{18}O_2 \rightarrow 2\ {}^{16}O^{18}O$ REACTION. Antoshin, G. V.; Minachev, Kh. M.; Kokhuaru, M. E.; Dmitriev, R. V.; Kuznetsov, A. V. (Inst. of Organic Chemistry, Moscow). Khim. Vys. Energ., 2: 478-9(Sept.-Oct. 1968). (In Russian).

Gamma radiation effects on catalytic properties of La_2O_3 and CeO_2 in the isotopic exchange reaction $^{16}O_2 + {}^{18}O_2 = 2\ {}^{16}O^{18}O$ were studied. The curves of La_2O_3 catalytic activity in a γ field and outside the radiation field indicate that γ radiation induced strong changes in the catalytic properties of the oxide. While under ordinary conditions the reaction practically stopped at temperatures below 350°C in the γ field the process continued below 150°C and up to the temperature of liquid nitrogen. Identical data were obtained for CeO_2. (R.V.J.)

4663 RADIATION EFFECTS IN POLYPROPYLENE AND ETHYLENE–PROPYLENE COPOLYMERS. Odian, George; Lamparella, Don; Canamare, Joseph (Columbia Univ., New York). J. Polym. Sci., Part C, No. 16, 3619-23(1968).

From IUPAC Meeting on Macromolecular Chemistry, Prague. See CONF-650801.

The effects of radiation on various propylene and ethylene–propylene copolymers were followed by observing the gel fraction as a function of radiation dose. The G (crosslink) and β/α values were calculated from the solubility data and are discussed in terms of the polymer composition. Allyl methacrylate was found to greatly increase the efficiency of radiation crosslinking of both polypropylene and an ethylene–propylene copolymer. (auth)

4664 RADIATION-INDUCED POLYMERIZATION OF DIENES WITH SULFUR DIOXIDE. Kearney, J. J.; Stannett, V.; Clark, H. G. (Research Triangle Inst., Durham, N. C.). J. Polym. Sci., Part C, No. 16, 3441-54(1968).

From IUPAC Meeting on Macromolecular Chemistry, Prague. See CONF-650801.

Copolymers of sulfur dioxide and butadiene, isoprene, 2,3-dimethylbutadiene, and chloroprene were prepared by irradiation at low temperatures with remarkably high efficiency. The polymers were all insoluble in the monomer mixtures and therefore only limited kinetic data were obtained. However, certain conclusions could be reached from the data. Isoprene, butadiene, and 2,3-dimethylbutadiene all produced 1:1 copolymers with sulfur dioxide across a wide range of temperature and composition. At high sulfur dioxide contents the cyclic sulfones began to form. Chloroprene behaved differently in that copolymers containing considerably more than 50 mole % of chloroprene were obtained. Also, the infrared spectra revealed a considerable proportion of pendant vinyl groups as compared with the predominantly 1,4 addition in the case of the other dienes studied. The isoprene and 2,3-dimethylbutadiene polymers were found to be soluble in highly polar solvents containing dissolved salts. At lower temperatures the radiation caused concurrent degradation of the polymer. The compositions of isoprene, 2,3-dimethylbutadiene, and sulfur dioxide terpolymers were found to be unusually sensitive to the polymerization temperature. Thermal gravimetric analysis of the various polymers showed thermal stabilities in the order, 2,3-dimethylbutadiene > isoprene and butadiene > chloroprene. A sample of tetramethylene polysulfone prepared chemically showed greatly enhanced thermal stability, catastrophic degradation beginning about 100°C higher than the corresponding butadiene copolymer. Attempts to hydrogenate the diene copolymers were unsuccessful although the corresponding cyclic sulfones were hydrogenated successfully. The highly efficient radiation polymerizations are believed to be free radical in nature and to proceed via monomer complex function. The difficulty of chain termination between sulfonyl radicals is suggested as a reason for the very high yields and molecular weights obtained at low temperatures. (auth)

4665 ALKYL DERIVATIVES OF PYROCATECHOL AS STABILIZERS IN γ-IRRADIATED POLYPROPYLENE. Nechitailo, N. A.; Sanin, P. I.; Polak, L. S.; Pospisil, J. (Inst. of Petrochemical Synthesis, Moscow. Inst. of Macromolecular Chemistry, Prague). J. Poly. Sci., Part C, No. 16, 3433-40(1968).

From IUPAC Meeting on Macromolecular Chemistry, Prague. See CONF-650801.

Studies were conducted on the stabilizing effect of dialkyl derivatives of pyrocatechol types I to III and 2-alkoxyphenol types IV and V in polypropylene irradiated under vacuum with a dose of 110 or 228 MRad. It was found that some derivatives, particularly those containing a bulky tertiary butyl group in the o position to the hydroxyl group, retard the destruction of the poly-

mer and formation of crosslinks, protecting at the same time irradiated polypropylene against subsequent oxidation. In the studied series of pyrocatechol derivatives the structural dependencies are well visible although the interpretation of results is probably also affected by the direct action of γ radiation on the stabilizers. (auth)

4666 RADIATION-INDUCED SOLID-STATE POLYMERIZATION OF A HOMOLOGOUS SERIES OF N-TERT-ALKYLACRYLAMIDES. Zurakowska-Orszagh, Janina (Univ. of Warsaw). J. Polym. Sci., Part C, No. 16, 3291-3300(1968).

From IUPAC Meeting on Macromolecular Chemistry, Prague. See CONF-650801.

A study on the solid-state polymerization of an homologous series of N-tert-alkylacrylamides under the action of γ radiation was carried out. More than twenty monomers of this series were prepared starting from N-sec-isopropylacrylamide and N-tert-butylacrylamide to N-tert-tetradecylarylamide. Some N-arylacrylamides and N-arylmethacrylamides were included also. For comparison the polymerization in solution of the same series of monomers induced by radiation as well as by chemical initiators was investigated. Results obtained for the series of N-tert-heptylacrylamides and N-tert-hexylacrylamides were discussed in more detail. An interesting coincidence between the reactivity of the particular isomers in the solid state and in solution was observed also for the radioinduced as well as chemically initiated polymerization. The comparison of melting points of both isomer series with their reactivity in the solid state shows that, in general, higher polymerization rates correspond to lower melting temperatures. The role of the symmetry and the structure of the homologous substituents on the polymerization rate was observed. (auth)

4667 AROMATIC AND SULFUR-CONTAINING AMINO ACIDS AS ACCEPTORS IN WATER RADIOLYTIC OXIDATION COMPONENT. Sharpatyi, V. A.; Zakatova, N. V.; Brodskaya, G. A. (Inst. of Chemical Physics, Moscow. Inst. of Nuclear Physics, Tashkent). Khim. Vys. Energ., 2: 473-4(Sept.-Oct. 1968). (In Russian).

Quantitative reactions of sulfur-containing amino acids and aromatics with OH^- radicals (OH^- is the oxidation component of water radiolysis, with O^- at pH ≥ 11.5) in the presence of products of ionized and excited water molecules and maximum energy absorbed by water in the solution were analyzed. Concentrated strongly alkali potassium hydroxylamine disulfonate (HADS) solutions were used. In the presence of competing additives radiation yields of the recorded radicals for potassium peroxylamine disulfonate (PADS) were reduced in relation to the increase of additive concentration. It was assumed that only two processes take place in the solution: HADS + OH^- → PADS and additive + OH^- → products. Relative reaction rate constants were determined using a steady-state method along the dip of linear anamorphosis of the function 1/G (PADS) to the ratio of additive/HADS. Reactions of substances (β-phenylalanine, tyrosine, tryptophan, cystine, alanine, glycine, human cerum albumen, benzene, phenol, indole, and other) with HO^- radicals are tabulated. (R.V.J.)

4668 PROCESS AND ARRANGEMENT FOR RADIATION-CHEMICAL REACTIONS. Herzog, W.; Wacker, A.; Rosinger, S. (to Farbwerke Hoechst Aktiengeselischaft). Canadian Patent 792,224. Aug. 13, 1968. Priority date Sept. 6, 1963, Germany.

An arrangement is described for exposing the reaction mixture to radiation outside of the reactor vessel between the wall of the vessel and the biological shield of a power reactor. The thermal shield is replaced entirely or partially by the vessel for the chemical reaction and reaction mixture, which may be in solid, liquid, or gaseous phase. Variations include a neutron absorber with small γ attenuation or an aqueous solution of B or Cd instead of the thermal shield. (F.S.A.)

4669 ESR OF SINGLE CRYSTALS OF SUCCINIC ACID γ IRRADIATED AT 195°K. Klinck, R. E. (Duke Univ., Durham, N. C.). J. Chem. Phys., 49: 4722-4(Nov. 15, 1968).

The ESR spectrum of the radical $CH_3CHCOOH$ (I) was studied after the γ irradiation at 195°K of succinic acid. The concentration of (I) was increased by uv irradiation at 2537 Å following the initial γ irradiation. The uv results suggest that I arises from the trapped electron species, (II) postulated by Miyagawa to account for the broad peak in the ESR spectrum observed with high microwave power fields. The signals due to I were unaffected by annealing of a γ-irradiated crystal of succinic acid at 60°C for 1 hr, thus indicating that I is quite stable. The formation of I occurs only upon irradiation. When the sample is removed from the ^{60}Co source, the II that remains in the crystal does not decay to I. However, it can be converted to I by uv irradiation at the proper wavelength. (D.H.M.)

4670 ISOTOPE PRODUCTION AND DEVELOPMENT. Baker, P. S. (Oak Ridge National Lab., Tenn.). Isotop. Radiat. Technol., 6: 131-45(Winter 1968-69).

Various production methods and uses of isotopes are reviewed. Ten radioisotopes, ^{144}Ce, ^{242}Cm, ^{244}Cm, ^{60}Co, ^{137}Cs, ^{147}Pm, ^{210}Po, ^{238}Pu, ^{90}Sr, and ^{170}Tm are considered in detail. (J.G.B.)

4671 DEPENDENCE OF RADIATION-INDUCED CONDUCTANCE OF LIQUID HYDROCARBONS ON MOLECULAR STRUCTURE. Tewari, P. H.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Chem. Phys., 49: 4394-9(Nov. 15, 1968).

The radiolytic ion mobilities u, ion-neutralization rate constant k, steady-state radiation-induced conductance κ, and free-ion yield G_{fi} were measured for a number of saturated hydrocarbon liquids of different molecular shape. The values of G_{fi} in the following liquids at 20°C were: cyclohexane, 0.11; n-hexane, 0.11; n-pentane, 0.12; 2,2-dimethylbutane, 0.40; 2,2-dimethylpropane, 0.81. The unusually high values for the last two compounds were partly associated with a current "overshoot" that occurred at the beginning of current-vs-time oscillograms that were obtained for the evaluation of k/u. The overshoot was not present in oscillograms obtained from the first three liquids. The causes of the overshoot and the high G_{fi} values are not known, but their magnitudes correlate with the closeness to spherical shape of the molecules. The facility of electron trapping and of electron energy loss in the subvibrational-excitation energy region are probably dependent on molecular shape and on liquid structure, in addition to electron affinities and dipole moments. The overshoot was eliminated and G_{fi} was reduced by adding an electron scavenger to 2,2-dimethylbutane or 2,2-dimethylpropane. Electron scavengers had little or no effect on the other liquids. (auth)

4672 PROCESS RADIATION DEVELOPMENT. Ballantine, D. S. (Atomic Energy Commission, Washington, D. C.). Isotop. Radiat. Technol., 6: 164-73(Winter 1968-69).

The objectives, survey procedures, and descriptions of commercial radiation processes are reviewed. General observations are included on the potential of, company attitudes toward, patent policies for, and the role of development work in radiation processing supported by Division of Isotopes Development of the USAEC. The need for better university, management, and public information programs, dissemination of radiation processing engineering and design data, and AEC-industry cooperative projects is stressed. A bibliography of reports published under the Division of Isotopes Development's process radiation program is included. (J.G.B.)

4673 ISOTOPE EFFECTS IN THE SZILARD-CHALMERS REACTIONS OF HAFNIUM AND ZIRCONIUM PHTHALOCYANINE. Hillman, Manny; Kim, C. K.; Shikata, Eiji; Weiss, A. J. (Brookhaven National Lab., Upton, N. Y.). Radiochim. Acta, 9: 212-18 (Oct. 1968).

Retentions following (n,γ) reactions were measured for various isotopes of zirconium and hafnium as phthalocyanines, as solids and in solution in DMSO. Isotope effects were determined for $^{95}Zr/^{97}Zr$, 1.60 ± 0.08, and for $^{180m}Hf/^{181}Hf$, 2.11 ± 0.07. No isotopic difference was observed between ^{175}Hf and ^{181}Hf. Retentions were also determined following (n,n') and (n,2n) reactions using 14 MeV neutrons. A substantial fraction of the retentions from the (n,γ) reactions are interpreted as primary retentions, the balance due to recombination and/or displacement reactions. The isotope effect is interpreted as being due to the differences in recoil energy spectra of the product nuclides. These differences can ultimately be attributed to the differences in spin change from the target nuclide to the product. (auth)

4674 HYDROGEN FORMATION IN THE RADIOLYSIS OF LIQUID n-BUTANE. Shida, Shoji; Fujisaki, Noboru; Hatano, Yoshihiko (Tokyo Inst. of Tech.). J. Chem. Phys., 49: 4571-5(Nov. 15, 1968).

The effects of a radical scavenger (C_2H_4) and electron scavengers (N_2O or SF_6) on hydrogen formation in the radiolysis of liquid n-butane at room temperature were studied. Further, the isotopic composition of the hydrogen from n-C_4H_{10}–n-C_4D_{10}, n-C_4H_{10}–n-C_4D_{10}–0.3M N_2O, and n-C_4H_{10}–n-C_4D_{10}–0.15M C_2H_4 mixtures were measured, and the ratios of unimolecular to biomolecular hydrogen formation determined for each mixture. Combining these results, the yields of six primary processes by which hydrogen is formed were determined separately with the results that G(thermal hydrogen atom), G(hot hydrogen atom), and G(molecular hydrogen) are, respectively, 0.7, 1.4, and 0.6 by direct excitation and ionization and 0.5, 0.6, and 1.0 by neutralization, with probable errors ±0.2. It is noticeable that the largest contribution is from hot hydrogen atoms produced by direct excitation and ionization. (auth)

4675 ROLE OF IONS AND ELECTRONS IN LIQUID-PHASE RADIOLYSIS OF CYCLOHEXANE. Polak, L. S.; Chernyak, N. Ya.; Shcherbakova, A. S. Khim. Vys. Energ., 2: 317-24(July-Aug. 1968). (In Russian).

The liquid-phase γ-radiolysis of cyclohexane was studied in the presence of phenyl and ethyl halides as electron acceptors. The number of ion-electron pairs, the recombination of which was averted due to the capture of electrons by a molecule of additive, corresponded to decreases in yields of hydrogen and benzene or ethane (and ethylene), which are formed by the dissociative capture of electrons by molecules of phenyl or ethyl halides, respectively. Comparison of the behavior of the compounds used showed that it is necessary to consider, first, formation of ion-electron pairs at various stages before recombination, and, secondly, capture by additives not only of thermal, but of epithermal, electrons (with energy of 1 eV). The values of rates of capture of electrons by the additives used were determined along with radiation yields of ion-electron pairs, $G_1 = 1.6 \times 10^{-2}$ and $G_2 = 2.5 \times 10^{-2}$ eV during lifetimes of 10^{-7} and 10^{-9} sec, respectively. (tr-auth)

4676 RADIOLYSIS OF CARBON DIOXIDE. Anderson, A. R.; Dominey, D. A. (Atomic Energy Research Establishment, Harwell, Eng.). Radiat. Res. Rev., 1: 269-300(Oct. 1968).

Experimental evidence for various developments in the radiolysis of CO_2 is reviewed, and the actual mechanisms of decomposition and reformation of CO_2 are discussed. Other topics such as the radiation chemistry of CO or C_3O_2 (carbon suboxide) are included only insofar as they relate to the main theme. (112 references). (P.C.H.)

4677 ELECTRONIC ENERGY TRANSFER IN IRRADIATED AROMATIC MATERIALS. Voltz, R. (Centre de Recherches Nucleaires, Strasbourg). Radiat. Res. Rev., 1: 301-60(Oct. 1968).

Discussion is presented on the intermolecular excitation energy transfer processes that follow the primary action of high-energy particles on condensed aromatic media. By analyzing typical experimental data in the light of simple theoretical arguments, it was concluded that, in non-diluted pure materials, the molecular excitation energy may be transferred away from its original site of formation, via the primary upper singlet levels, as well as from the lowest excited states. In the former case, the transfer efficiency from the initial to a final site is favored by the large resonance interaction energy, but limited by the short lifetime of the highly excited primary states. For the lowest excited states, by contrast the resonance interaction is, in general, relatively smaller, but the transfer efficiency is still notable, due to longer lifetimes. A review is also given on the elementary energy transfer mechanisms that are expected to be operative in aromatic media, with special attention given to the conditions under which the elementary models apply. (153 references). (P.C.H.)

4678 RADIATION CHEMISTRY OF AQUEOUS GLASSES. Brown, D. M.; Dainton, F. S. (Leeds Univ., Eng.). Radiat. Res. Rev., 1: 241-68(Oct. 1968).

The radiation chemistry of aqueous glasses is discussed as revealed by the matrix isolation and ultimate product analysis techniques and its relation to the radiation chemistry of liquid aqueous systems. This includes radiation effects on aqueous, acid, alkaline, and neutral glasses, and crystalline aqueous solutions. Experimental methods used in the studies are also briefly mentioned. (P.C.H.)

4679 EFFECTS OF LET ON THE PROTON RADIOLYSIS OF SODIUM NITRATE. Eremin, L. P.; Oblivantsev, A. N.; Boldyrev, V. V. Khim. Vys. Energ., 2: 176-9(Mar.-Apr. 1968). (In Russian).

The radiolysis of sodium nitrate was studied at 25 to 180°C and at various proton energies. It was established that the relation of the radiation yield of NO_2^- is a function of the magnitude of LET and has a maximum at room temperature. At 180°C $G(NO_2^-)$ is uniformly decreased with increased LET. This is explained by the increase of the probability of the reverse processes at greater LET and by the effects of the thermal peaks at low temperatures. (tr-auth)

4680 EFFECTS OF γ RADIATION ON COPOLYMERS OF ETHYLENE WITH PROPENE AND 1-BUTENE. Dzhibgashvili, G. G.; Egorova, Z. S.; Leshchenko, S. S.; Slovokhotova, N. A.; Karpov, V. L. Khim. Vys. Energ., 2: 172-5(Mar.-Apr. 1968). (In Russian).

Studies on the effects of ^{60}Co γ irradiation on copolymers of ethylene with 7 mole % propene and 3 mole % 1-butene showed that radiation bonding was higher in ethylene copolymers with 1-butene. The formation of bonds in copolymers of low-pressure polyethylene was measured. The ir absorption spectra showed that the formation of trans-vinylene double bonds in low-pressure polyethylene is highest. The formation of vinyl and vinylidene double bonds were observed during irradiation at high doses. (tr-auth)

4681 RADIOLYSIS OF ALKANESULFONYLCHLORIDES IN THE PROCESS OF RADIATION SULFOCHLORINATION OF PARAFFIN HYDROCARBONS. Dzhagatspanyan, R. V.; Lyaskin, Yu. G.; Gershenovich, A. I.; Makarochkina, L. M.; Onishchenko, T. A.; Balakirev, E. S. Khim. Vys. Energ., 2: 159-64(Mar.-Apr. 1968). (In Russian).

The role of γ radiolysis in the process of radiation sulfochlorination of alkanes was studied using the compounds cyclohexanesulfonylchloride, 1-hexanesulfonylchloride, and also the products of sulfochlorination of petroleum distillates and low-molecular-weight paraffins. The results showed that the radiolysis of sulfonyl chlorides is an energy-consuming process and consists mainly of the separation of SO_2 and HCl with the formation of olefins. It was established that the radiolysis of sulfonyl chlorides cannot influence the final yields in the sulfochlorination of industrial mixtures of hydrocarbons and the physicochemical properties of the products. (tr-auth)

4682 EFFECTS OF TEMPERATURE AND OXYGEN ON THE COMPOSITION OF PRODUCTS IN THE γ RADIOLYSIS OF HEPTANE. II. DIMERIC HYDROCARBONS. Pichuzhkin, V. I.; Saraeva, V. V.; Bakh, N. A. Khim. Vys. Energ., 2: 155-8(Mar.-Apr. 1968). (In Russian).

The effects of temperature on the yields of tetradecane isomers in the γ radiolysis of n-heptane in the presence and absence of oxygen were studied. It was found that the composition of tetradecane isomers depends upon the irradiation conditions. With an increase in temperature the number of isomers, which were formed by reactions of secondary heptyl radicals, increased. The yields of isomers that were formed from primary heptyl radicals (free valence at atom C-1) decreased with an increase in temperature. It was concluded that primary heptyl radicals are capable of being transformed into secondary heptyl radicals. Oxygen reduced the tetradecane yield up to a certain value and changed its isomeric composition with no effects of temperature. The results concerning the initial distribution of heptyl radicals produced by the action of γ radiation on n-heptane were discussed. (tr-auth)

4683 EFFECTS OF TEMPERATURE AND OXYGEN ON THE COMPOSITION OF PRODUCTS IN THE γ RADIOLYSIS OF HEPTANE. I. HYDROGEN AND HYDROCARBONS WITH THE NUMBER OF CARBON ATOMS FROM 1 TO 12. Pichuzhkin, V. I.; Saraeva, V. V.; Bakh, N. A. Khim. Vys. Energ., 2: 151-4(Mar.-Apr. 1968). (In Russian).

Studies were made on the yields of hydrocarbons in the γ radiolysis of n-heptane at different temperatures in the presence and absence of oxygen. Yields of light hydrocarbons in heptane at low pressure were increased, while the yields of hydrocarbons C_3 to C_{12} decreased with increase in temperature. It was established that oxygen reduces the yields of all hydrocarbon products and hydrogen although temperature did not have any effect on the yields in the presence of oxygen. It was concluded that the increase in the yields of light hydrocarbons occurs as a result of the interaction of light radicals with molecules of heptane. (tr-auth)

4684 EPR STUDY ON PHOTOCHEMICAL REACTIONS OF FREE RADICALS IN γ-IRRADIATED POLYACRYLATE AT 77°K. Vinogradova, V. G.; Shelimov, B. N.; Fok, N. V. Khim. Vys. Energ., 2: 128-35(Mar.-Apr. 1968). (In Russian).

Studies were made on the effects of light of different wavelengths (λ = 290 to 650 mμ) on free radicals produced by γ radiolysis of polymethacrylate, poly(methyl methacrylate), and polyacrylate at 77°K. It was found that the radicals $\sim CH_2 - \overset{CH_3(H)}{\overset{|}{C}}\sim$ ($\overset{|}{}$ COOCH$_2$) decompose under uv light, giving HCO, CH_3, and oxygen atoms with free valence. The last is stable to the effects of visible and uv light. The polymer radicals, which were formed as a result of the attachment of CH_3 to C = O, were sensitive to the effects of uv light. (tr-auth)

4685 REACTIONS OF RECOILING SILICON ATOMS WITH PHOSPHINE, SILANE, AND ETHYLENE. Gaspar, Peter P.; Bock, S. Allan; Eckelman, William C. (Washington Univ., St. Louis). Contract AT(11-1)-1713. J. Amer. Chem. Soc., 90: 6914-22(Dec. 4, 1968). (COO-1713-3).

Fast-neutron irradiation of phosphine produces neutral ^{31}Si atoms whose chemically stable end product is $^{31}SiH_4$. Phosphine–silane mixtures yield $H_3{}^{31}SiSiH_3$ and $^{31}SiH_4$, the product ratio increasing rapidly with silane concentration until a plateau value

of 4.8 ± 0.9 is reached at ca. 20% silane. The absolute yields increase linearly with silane concentration over the range (0 to 80%) studied. The yield vs. composition data are accommodated by a kinetic scheme in which a single species reacts with silane and phosphine to give $^{31}SiH_4$, with silane to give $H_3{}^{31}SiSiH_3$, and with phosphine to give an involatile product. The major product from 1:1 phosphine–ethylene mixtures is tentatively identified as $^{31}SiH_3CH_2CH_2PH_2$. The occurrence of a "hot" process in the reaction sequence is indicated by a large moderator effect on the absolute yields of products from phosphine–silane mixtures. (auth)

4686 GRUNDZUEGE DER RADIO- UND REAKTORCHEMIE. (Principles of Radio- and Reactor Chemistry). Hecht, Friedrich. Frankfurt am Main, Akademische Verlagsgesellschaft, 1968. 434p.

Topics covered include: nuclear physics data, nuclear reactions, radiation measurements, radiochemical work methods, artificial radioactivity, nuclear reactors, radiation effects and radiation burden, use of radioisotopes in industry and medicine, and chemistry of hot atoms. (M.C.G.)

4687 ORIGIN AND ROLE OF OPTICAL ISOMERY IN LIFE. Garay, A. S. (Inst. of Plant Breeding, Fertoed, Hungary). Nature (London), 219: 338-40(July 27, 1968).

When D and L isomers of tyrosine were bombarded with β particles the D isomer decomposed more quickly. A possible reaction mechanism would have relevance to the origin of life. (auth)(UK)

4688 RECENT APPROACHES IN THE STUDY OF HOT ATOM CHEMISTRY OF SOLID SUBSTANCES. Maddock, Alfred G. (Chemical Labs., Cambridge, Eng.). Nippon Genshiryoku Gakkaishi, 10: 637-44(Nov. 1968). (In Japanese).

A review is presented on studies on the peculiar behaviors observed on thermal and radiation annealing of certain simple solid substances, both inorganic and organic, after neutron irradiation, and discussions are given based on the various models presented for interpreting the data. Special emphasis is placed on the significance of introducing the general concepts of solid state physics (such as those on lattice defects) into the usual radiochemical approaches to this problem. (auth)

4689 ClOH$^-$ RADICAL: ELECTRON SPIN RESONANCE EVIDENCE FROM γ-IRRADIATED BARIUM CHLORIDE HYDRATE. Catton, R. C.; Symons, M. C. R. (Univ. of Leicester, Eng.). Chem. Commun., No. 23, 1472(1968).

Two radicals were detected in γ-irradiated $BaCl_2$, $2H_2O$, the less thermally stable being a normal Cl_2^- ion and the other a radical having ESR properties in accordance with ClOH$^-$. ESR parameters are tabulated for both radicals. It is concluded that ClOH$^-$ is a σ-radical of the same type as the V_K-centres and that the spin density is distributed to give about 0.4 on the Cl-atom. The radical should show chemical properties similar to those of OH-radicals. (UK)

4690 EFFECT OF DOSE-RATE IN THE RADIOLYSIS OF LIQUID CYCLOHEXANE. Burns, W. G.; Reed, C. R. V. (Atomic Energy Research Establishment, Harwell, Eng.). Chem. Commun., No. 23, 1468-9(1968).

When liquid cyclohexane is irradiated with radiation of increasing LET, changes occur in the yields of the major products H_2, cyclohexane, and bicyclohexyl. Such effects are considered due to competition between first and second order reactions of short-lived intermediate species, and mechanisms based on the competing reactions of H-atoms and of excited molecules have been suggested. It was expected that similar trends would be shown with increasing dose rate, and that if competing reactions of H-atoms were the cause of a dose rate effect, then decreases in condensed product yields would be expected in the dose rate range 10^{25} to 10^{28} eV/g/sec. Using an electron linear accelerator to achieve such dose rates, changes in product yield ratios in the expected direction were found. Irradiation was with 2 μsec pulses of ~0.7 MR per pulse, with a pulse repetition rate of 50 to 150 per sec, and total dose ~10^{19} eV/g at ~2×10^{25} eV/g/sec. Values for $G(C_6H_{10})$ and $G(C_{12}H_{22})$ are tabulated for these high dose rates. (UK)

4691 PULSE RADIOLYTIC DETERMINATION OF THE ULTRAVIOLET ABSORPTION OF HYDROGEN ATOMS IN AQUEOUS SOLUTION. Neilsen, S. O. (Danish Atomic Energy Commission Research Establishment, Risoe); Pagsberg, P.; Rabani, J.; Christensen, H.; Nilsson, G. Chem. Commun., No. 23, 1523-4(1968).

Pulse radiolysis of deaerated aqueous solutions of 10^{-3}M $HClO_4$ + 0.027 M H_2 revealed an optical absorption transient at 2,000 to 2,300 Å, which is assigned to the presence of free H-atoms in the solution. Pulsing was at 1.2 μsec and the dose was ~10^{20} eV/l (electron). Accurate measurements were made of the absorption transient ($t_{\frac{1}{2}}$ ~ 8 μsec) down to 2,000 Å and from 0.2 μsec after pulsing. Results and mechanisms are discussed, and calculated molar decadic absorptivities of H are tabulated over the range 2,000 to 2,500 Å. The absorption was found to decay by second order kinetics. It is considered that the absorption spectrum of H-atoms at 2,000 to 2,300 Å may account for most of the previous anomalies observed in pulse radiolysis studies of N_2O, H_2O_2, and $HClO_4$ aqueous solutions. (UK)

4692 REACTIONS OF HYDRATED ELECTRONS WITH INORGANIC COMPOUNDS. Anbar, M. (Stanford Research Inst., Menlo Park, Calif.). Quart. Rev. (London), 22: 578-98(1968).

The subject is reviewed under the following headings: reactions of hydrated electrons and their products (hydrogen and its oxides; the alkali metal ions, alkaline earths, and rare gases; compounds of elements of Group III and the lanthanides; compounds of elements of Group IV; compounds of elements of Group V; compounds of elements of Group VI; the halogens and their compounds; the transition metal ions and their complexes); mechanisms of reactions of hydrated electrons with inorganic compounds (energy of activation of reactions of hydrated electrons; primary products of reactions of the hydrated electron; mechanism of electron transfer); conclusions. (86 references). (UK)

4693 RADIATION SORPTION OF OXYGEN ON CADMIUM SULFIDE. Niyazov, Kh. R.; Kolomazov, R. U.; Chekhomova, L. A. Khim. Vys. Energ., 2: 349-51(July-Aug. 1968). (In Russian).

The sorption of oxygen by cadmium sulfide in a ^{60}Co gamma field was discovered. It was established by the character of the temperature relation and by the quantity of the effect that radiation sorption differs from chemisorption of O_2 on CdS. The complete reversibility of radiation sorption is shown. (tr-auth)

4694 INVESTIGATION OF PARAMAGNETIC CENTERS IN GAMMA-IRRADIATED Y-TYPE ZEOLITES BY THE METHOD OF ELECTRON PARAMAGNETIC RESONANCE. Tupikov, V. I.; Malkova, A. I.; Sorokin, Yu. A.; Pshezhetskii, S. Ya. Khim. Vys. Energ., 2: 352-8(July-Aug. 1968). (In Russian).

The influence of gamma radiation on synthetic Y-type zeolites with different cation substituents was studied by the EPR method. Independently of the type of cation the EPR spectra of gamma-irradiated zeolites are singlets with a width of 36 to 38 Oe, with reference to stabilized electrons. The possible places of stabilization are the pairs of vacancies and positive and negative ions. On adsorption of oxygen on previously irradiated zeolite the EPR spectra of stabilized electrons are changed reversibly to the spectra of O_2^- ion radicals. (tr-auth)

4695 INFLUENCE OF GAMMA IRRADIATION ON CATALYTIC ACTIVITY OF LANTHANUM OXIDE IN HOMOMOLECULAR ISOTOPIC EXCHANGE REACTIONS OF OXYGEN. Sazonov, L. A.; Sokolovskii, V. D.; Mitrofanova, G. N. Khim. Vys. Energ., 2: 359-62(July-Aug. 1968). (In Russian).

Irradiation of La_2O_3 by gamma rays from ^{60}Co increases its catalytic activity by approximately two orders. The activation energy of the reaction is equal to 2.7 ± 0.2 kcal/mole. Above −115°C there is a rapid reduction of induced catalytic activity as a result of annealing of active centers formed on irradiation. The radioinduced relaxation of catalytic activity has a maximum and minimum, but the maximum shifts to the side of lesser radiation doses on increasing the heating time of the specimen in vacuum before irradiation. (tr-auth)

4696 RADIOLYSIS OF ACETONE. III. AQUEOUS ACETONE MIXTURES. Karasev, A. L.; Larin, V. A.; Veselovskaya, N. V.; Bakh, N. A.; Sorokin, V. V. Khim. Vys. Energ., 2: 325-30(July-Aug. 1968). (In Russian).

Final products from the radiolysis of aqueous acetone mixtures were studied in the concentration range from 5×10^{-3} M up to anhydrous acetone. Yields were calculated for the following radiolytic products: H_2, CH_4, C_2H_6, CO, iso-C_3H_7OH, $(CH_2COCH_3)_2$, $[(CH_3)_2COH]_2$, CH_3CHO, CH_3COOH, $C_2H_5COCH_3$, $(CH_3CO)_2$, $CH_3COCH_2COCH_3$, CH_3COCH_2OH, and H_2O_2. The influences of temperature (−196, +26, and +50°C) on the yields of identified radiolytic products were established. At +26 and −196°C maximum values were observed for iso-C_3H_7OH, $CH_3COC_2H_5$, $[(CH_3)_2COH]_2$, $(CH_3COOCH_2)_2$, and CH_3COCH_2OH in the region of 0.75 to 0.80 mole fraction of water in acetone. It was in this region that the different physicochemical properties of this system also showed extreme values. Accumulation and extinction of the radicals formed in the solid phase were studied by EPR methods. In the region of 0.75 mole fraction water the maximum value (G = 11.2) of the radical yield was observed. Maximum yields of the following radicals were determined: for H and CH_2COCH_3

(G = 9.0) and for $CH_3C(OH)CH_3$ G = 2.2. The observed behavior of aqueous acetone mixtures in liquid and solid phases is explained by the specific structure, which emerges in the ratio water : acetone = (3-4) : 1. (tr-auth)

4697 INVESTIGATION USING MOESSBAUER EFFECT OF MECHANISM OF THERMAL STABILIZATION OF IRRADIATED POLYETHYLENE BY CERTAIN ORGANIC TIN COMPOUNDS. Aleksandrov, A. Yu.; Baldokhin, Yu. V.; Braginskii, R. P.; Gol'danskii, V. I.; Korytko, L. A.; Leshchenko, S. S.; Oinkel, E. E. Khim. Vys. Energ., 2: 331-7(July-Aug. 1968). (In Russian).

The method of gamma resonance spectroscopy was used to study the mechanism of stabilization of irradiated polyethylene by certain organic tin compounds. On irradiation of polyethylene, polymer chains combined with butyl radicals, formed by the radiolysis of initial stabilizers, which block the free valences appearing in the polymer chain. (tr-auth)

4698 CHANGE OF ELECTRIC CONDUCTIVITY AND INFRARED ABSORPTION SPECTRA OF ZINC OXIDE ON CHEMISORPTION OF HYDROGEN AND OXYGEN UNDER ACTION OF GAMMA RADIATION. Gezalov, A. A.; Spiridonov, K. N.; Zhabrova, G. M. Khim. Vys. Energ., 2: 363-8(July-Aug. 1968). (In Russian).

The effects of gamma-induced chemisorption of O_2 and H_2 on the electric conductivity and infrared absorption of ZnO were studied. Manometric measurements were conducted simultaneously with electric conductivity measurements on powdered ZnO at one radiation dose. The infrared spectra in the field from 900 to 2000 cm^{-1} were recorded after irradiation. An assumption was made concerning the electronic character of radiation chemisorption of both gases on the basis of changes in electric conductivity during the course of chemisorption during irradiation and on the basis of infrared spectra. A possible mechanism of radiation chemisorption is discussed. (tr-auth)

4699 SOLID-STATE RADIATION POLYMERIZATION OF TETRAFLUOROETHYLENE. I. INVESTIGATION OF PARAMAGNETIC CENTERS WHICH APPEAR DURING IRRADIATION OF THE CRYSTALLINE MONOMER. Muromtsev, V. I.; Bruk, M. A.; Asaturyan, R. A.; Akhvlediani, I. G.; Abkin, A. D. Khim. Vys. Energ., 2: 369-73(July-Aug. 1968). (In Russian).

Results are given of the experimental investigations of radicals formed on irradiation of polycrystalline tetrafluoroethylene. The individual spectra of six paramagnetic centers were isolated by analysis of the relaxation effects. Certain aspects of the identification of these centers are discussed. (tr-auth)

4700 X-RAY CHEMILUMINESCENCE OF AQUEOUS SOLUTIONS OF AMINO ACIDS, PEPTIDES, AND PROTEINS. Silaev, Yu. V.; Shiryaev, V. M.; Sapezhinskii, I. I. Khim. Vys. Energ., 2: 338-43(July-Aug. 1968). (In Russian).

X-ray chemiluminescence of aqueous solutions of salts, sugars, alcohols, nucleic acids, peptides, and proteins was studied. The most intensive chemiluminescence resulted on irradiation of tryptophan and of peptides containing tryptophan. Comparative data on afterglow were obtained for 12 proteins. The relation of luminescence yield to amino acid composition is discussed. (tr-auth)

4701 RADIOLYSIS OF MONOCRYSTALS OF LEAD AZIDE. Ryabykh, S. M.; Lysykh, A. P.; Zakharov, Yu. A. Khim. Vys. Energ., 2: 344-8(July-Aug. 1968). (In Russian).

The decomposition of PbN_6 by the action of x rays or fast protons was investigated. The degree of decomposition was judged by the quantity of nitrogen retained by the crystalline lattice of PbN. It is shown that the degree of decomposition is proportional to absorbed dose. Single-phase addition of Ag^+ accelerates, and Cu^{2+} slows down, radiolysis by fast protons. Results are discussed from the point of view of the influence of single-phase impurities on the electronic stages of the process. A relation close to straight proportionality was found to exist between the gamma-induced electric conductivity of PbN_6 and its solid solutions with Ag^+ or Cu^{2+} and their radiation-chemical stability. The possible mechanism of radiolysis of PbN_6 is proposed. (tr-auth)

4702 ISOCHRONIC ANNEALING OF IRON CUPFERRATE IRRADIATED BY NEUTRONS AND OF IRON CUPFERRATE DOPED WITH FERRIC HYDROXIDE. Calusaru, A.; Rusi, A. (Institut de Physique Atomique, Bucharest). Radiochim. Acta, 9: 210-12(Oct. 1968). (In French).

Iron cupferrate was irradiated with thermal neutrons. The retention was measured as a function of temperature at constant length of annealing. The observed curves indicate two different mechanisms for the annealing process. Corresponding curves were observed for the isotopic exchange in cupferrate of iron doped with labeled ferric hydroxide. The results of these investigations again indicate the occurrence of two mechanisms. Despite the analogy found for the two systems the slopes of the two curves, however, are different. This leads to the conclusion that the reactions of annealing in the irradiated material are different from those in the doped substance. (auth)

4703 PROCESS FOR THE PRODUCTION OF POLYFORMALDEHYDE. (to Houilleres du Bassin du Nord et du Pas-de-Calais). British Patent 939,498. Oct. 16, 1963. Priority date Jan. 24, 1961, France.

A process for the production of polyoxymethylene comprises subjecting trioxane containing 100 to 5000 ppM of polar impurities in the solid state to ionizing radiation at a temperature of from 10 to 1°C below the melting point of the trioxane and allowing the activated impure trioxane to polymerize in the solid state at a temperature of from 40 to 1°C below the melting point of trioxane after heating the trioxane to the latter temperature when necessary. The irradiation dose is less than 5000 RAD/1% conversion of trioxane to polyoxymethylene. The impurities and/or additives in the trioxane are one or more of the following: water, formaldehyde, and traces of formic acid and methanol resulting from Tischenko's reaction on formaldehyde. (B.L.M.)

4704 PROCESS FOR THE POLYMERIZATION OF ACRYLONITRILE. (to Rumanian Minister of Chemical Industry). British Patent 1,134,885. Nov. 27, 1968. Priority date Dec. 17, 1964, Rumania.

A homogeneous mixture of acrylonitrile with glycerol, methyl alcohol, and toluene is treated with ionizing radiation to polymerize the acrylonitrile. Polymers having a molecular weight between 50,000 and 200,000 are obtained. (B.L.M.)

4705 RADIATION INDUCED DEGRADATION OF METHYL CELLULOSE WITHOUT DEALKOXYLATION. Atchison, George J. (Dow Chemical Co., Midland, Mich.). Text. Res. J., 38: 1142(Nov. 1968).

Weight losses induced by electron irradiation were determined for solid Methocel MC 4000 and Methocel HG60 4000 cellulose ethers. The irradiation with 2 mV electrons in air at a high dose rate did not induce weight losses to exceed 0.13% up to a dose of 10 MRAD. Above this, the weight losses increased ~ linearly with dose amounting to ~3.5% at 50 MRAD. Specific activity measurements showed no loss of ^{14}C content of labeled methyl cellulose when the dry material was irradiated to 10 MRAD in air with accelerated electrons indicated negligible dealkoxylation. It was concluded that ionizing radiations can be used to reduce the effective molecular weight of methyl cellulose without producing dealkoxylation if the dry solid is irradiated in air at high dose rates. (B.L.M.)

4706 METHOD FOR PRODUCING CARBONYL COMPOUNDS. Oshima, Keiichi (to Yawata Chemical Industry Co.). Japanese Patent 1968-18889. Aug. 16, 1968. Filed Mar. 28, 1966.

To obtain carbonyl compounds using ionizing radiation, a gaseous mixture of saturated aliphatic hydrocarbon of carbon atom number 14 and carbon monoxide is irradiated, in the presence of a solid material onto which the two can adsorb, under pressure, preferably above 50 kg/cm^3, with either γ or x rays at 0.5 to 5 MeV. (NSA of Japan)

4707 RADIATION INDUCED POLYMERIZATION OF ACRYLONITRILE. Hussain, Fazal; Rashid, A.; Amjad, M. (Univ. of Punjab, Lahore). Pakistan J. Sci. Ind. Res., 11: 134-7(Apr. 1968).

Polymerization of acrylonitrile by gamma radiation has been studied at room temperature in the atmosphere of nitrogen or under vacuum. The polymer conversion was estimated gravimetrically. The parameters varied were the pH of the medium, radiation dose, and monomer concentration. The effects of sulfate and chloride ions on reaction rate under similar conditions of hydrogen ion concentration were also investigated. It was found that the polymer yield is maximum at pH 5.8 and decreases with the increase or decrease of pH of the medium. The chloride ions decrease the yield to a lesser extent than the sulfate ions. Polymerization occurs via free radicals formation. (auth)

4708 MEKHANIZM I KINETIKA RADIATSIONNO-KHIMICHESKIKH REAKTSII. IZDANIE VTOROE (PERERABOTANNOE I DOPOLNENNOE). (Mechanism and Kinetics of Radiochemical Reactions. Second Edition (Corrected and Expanded). Pshezhetskii, S. Ya. Moscow, Izdatel'stvo Khimiya, 1968. 368p.

The results of investigations in the field of mechanisms of radioinduced chemical reactions are summarized. References that were published up to 1967 are cited. Special attention is given to elemental processes that occur during the action of radiation on molecules, and also the role of different elemental processes in radioinduced reactions of the simplest inorganic

and organic compounds. The peculiarities of radioinduced processes in gaseous, liquid, and solid phase are also considered. (1131 references). (P.C.H.)

Radiochemistry

Refer also to abstracts 4587 and 4686.

4709 ELECTRON PARAMAGNETIC RESONANCE STUDY OF FREE-RADICAL REACTIONS INITIATED BY RADIOACTIVE DECAY IN SOLID NAPHTHALENE-1-t. Lloyd, R. V.; Magnotta, F.; Wood, D. E. (Carnegie-Mellon Univ., Pittsburgh). J. Amer. Chem. Soc., 90: 7142-4(Dec. 4, 1968).

The production of free radicals in pure, solid naphthalene by the radioactive decay of tritium specifically substituted into the naphthalene molecule is reported. In an EPR study two radical species were found, one previously unreported. The first, which appeared soon after the preparation of the sample and which was stable at liquid nitrogen temperature, was tentatively identified as 1-naphthyl. Radical II, which was stable at room temperature, was identified as 1-hydronaphthyl. (D.H.M.)

Separation Processes

Refer also to abstracts 4522, 4535, 4538, 4587, and 4823.

4710 (BARC-329) THE MECHANISM OF SEPARATION OF NIOBIUM AND TANTALUM BY CHLORINATION OF THEIR MIXED OXIDES BY CARBON MONOXIDE AND CHLORINE. Srinivasan, K. R.; Jena, P. K. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 10p. Dep.

An attempt was made to get an insight into the mechanism of preferential chlorination and hence the separation of niobium from tantalum by chlorination of their mixed oxides with CO and Cl_2. In addition to kinetic studies on the reaction between $TaCl_5$ and Nb_2O_5, results of earlier studies on the kinetics of chlorination of pure pentoxides of Nb and Ta by CO and Cl_2 were also taken into consideration. From these data, it was concluded that in spite of the fact that the chlorination of Nb_2O_5 requires a higher activation energy (E = 7.6 kcal/mole) than that of Ta_2O_5 (E = 5.1 kcal/mole), the comparatively fast reaction between $TaCl_5$ and Nb_2O_5 (E = 1.91 kcal/mole), $5\ TaCl_5 + 2\ Nb_2O_5 \rightarrow 2\ NbCl_5 + 2\ NbOCl_3 + 3\ TaOCl_3 + Ta_2O_5$, is the cause of the preferential chlorination of Nb_2O_5. (auth)

4711 (GAMD-7294) DESIGN STUDY AND ECONOMIC EVALUATION OF HEAD-END REPROCESSING FACILITY INTEGRAL WITH AN HTGR POWER PLANT. Stelling, H. E.; Steyer, K. G. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Aug. 18, 1966. Contract AT(04-3)-167. 114p. Dep. CFSTI.

Preliminary designs and costs were developed for nuclear fuel head-end reprocessing facilities integral with a large High-Temperature Gas-Cooled Reactor (HTGR) power plant. Head-end reprocessing is defined as that portion of reprocessing preliminary to solvent extraction or other uranium recovery process. The head-end operation in these studies produces ashes of uranium and thorium oxides, which are dissolved at a modified existing central reprocessing plant to make a feed solution for the solvent extraction operation. Ash shipping and final uranium and thorium recovery costs were estimated and added to head-end costs to yield total reprocessing and shipping costs. These costs, based on typical utility company financing with 30-year amortization, are summarized. Studies are underway to evaluate the economies of a reprocessing plant specifically designed to process HTGR fuels from a large HTGR economy. Also, the total costs shown include both shipping and reprocessing components. Reprocessing of two HTGR fuel element types is considered. Each type consists of loose, carbon-coated fuel particles contained within a graphite body. The graphite bodies are of different shapes; one is a long, slender rod, and the other is a short, hexagonal block. The burning and storage methods of fuel element waste graphite disposal also were examined. It was concluded that integral reactor head-end reprocessing is practical as a method of reducing the shipping cost portion of fuel cycle costs. Assuming that the cost figures can be linearly extrapolated, reprocessing with an integral head-end becomes cheaper than reprocessing in the modified existing central plant for stations of about 1200-MW(e) capacity when shipping distance is 2800 miles. The economical station size increases to 1500 to 1600 MW(e) for distances of 900 miles one way. (auth)

4712 (KFK-tr-232) UNTERSUCHUNGEN UEBER DIE TRENNUNG VON SPALTPRODUKTEN NACH DER FLOTATIONS-METHODE: DIE ABTRENNUNG VON ^{106}Ru. (Investigation of the Separation of Fission Products by Flotation: The Separation of ^{106}Ru). Koyanaka, Y. Translated into German by Peter Buriks (Kernforschungszentrum, Karlsruhe (West Germany)), from Kurri-tr-21. 9p. (In German). Dep.

4713 (KFK-tr-233) UNTERSUCHUNGEN UEBER DIE TRENNUNG VON SPALTPRODUKTEN NACH DER FLOTATIONS-METHODE: DIE ABTRENNUNG VON Cer. (The Separation of Fission Products by the Flotation Method: The Separation of Ce). Koyanaka, Y. Translated into German by Peter Buriks (Kernforschungszentrum, Karlsruhe (West German)), from Kurri-tr-19. 13p. (In German). Dep.

4714 (KFK-tr-242) UNTERSUCHUNGEN UEBER DIE TRENNUNG VON SPALTPRODUKTEN NACH DER FLOTATIONS-METHODE: DIE ABTRENNUNG VON ^{95}Zr-^{95}Nb. (The Separation of Fission Products by the Flotation Methods: The Separation of ^{95}Zr-^{95}Nb). Koyanaka, Y. Translated into German by Peter Buriks (Kernforschungszentrum, Karlsruhe (West Germany)), from Kurri-tr-24. 13p. (In German). Dep.

4715 (MLM-1521) STABLE GASEOUS ISOTOPE SEPARATION AND PURIFICATION: APRIL-JUNE 1968. (Mound Lab., Miamisburg, Ohio). Nov. 8, 1968. Contract AT(33-1)-Gen-53. 41p. Dep. CFSTI.

Studies on carbon isotope separation including distillation and thermal diffusion were continued. Chemical exchange of carbon dioxide-carbamate using a methoxy propylamine-methanol solution was further investigated. Developments in the separation of stable gaseous isotopes of Ar, Kr, Ne, and Xe are reported. Progress in thermal diffusion research on transport and column properties is also reported. New values for Kr and Xe transport coefficients are presented. Calculations for thermal transpiration in low temperature research are included. (J.G.B.)

4716 (RT/CHI-(68)28) SOL-GEL RESEARCH AND DEVELOPMENT IN ITALY. Zifferero, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 22p. (CONF-680532-1). Dep.

From Panel on Sol-Gel Processes, Vienna, Austria.

Research on sol-gel follows parallel lines, which include: basic chemistry of actinides in colloidal solution; mechanism of gelification and sintering; process chemistry and establishment of flow sheets; process development and research on specific unit operations; and product evaluation, irradiation testing, and economics. A description is given of the results so far achieved along the different lines. (auth)

4717 (SRO-123) REPROCESSING OF DRESDEN REACTOR FUEL AT NUCLEAR FUEL SERVICES, INC., WEST VALLEY FACILITY. (Savannah River Operations Office (AEC), Aiken, S. C.). Oct. 14, 1968. 109p. Dep. CFSTI.

A summary of processing experience on the first and second cores of the Dresden Reactor is presented, including specific data relating to processing operations, analytical laboratory operations, and nuclear materials accountability. Parameters by which the various mechanical and chemical operations would be run are given. Included is a sampling schedule and stream composition tables. Tables also summarize operations for fuel shearing, dissolution, and sampling of leached hulls. Nuclear Fuel Services accountability measurement methods are described along with AEC methods used to verify the accuracy of these measurements. (M.C.G.)

4718 (SRO-124) REPROCESSING OF YANKEE REACTOR FUEL AT NUCLEAR FUEL SERVICES, INC., WEST VALLEY FACILITY. (Savannah River Operations Office (AEC), Aiken, S. C.). Oct. 21, 1968. 94p. Dep. CFSTI.

Processing experience on the four initial discharges of fuel from the Yankee Reactor is summarized, including specific data relating to processing operations, analytical laboratory operations, and nuclear materials accountability. Parameters are set forth for the various mechanical and chemical operations. Tables are included that summarize operations for fuel shearing and dissolution. The Nuclear Fuel Services accountability measurement methods are described along with AEC methods used to verify these measurements. (M.C.G.)

4719 (UCRL-50499) CHEMICAL PROCESSING FACILITY TO RECOVERY ACTINIDE ISOTOPES PRODUCED IN UNDERGROUND NUCLEAR EXPLOSIONS. Quong, R.; McNabb, J. R. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 23, 1968. 18p. Dep. CFSTI.

A facility was developed to chemically process kilogram quantities of silicate rock containing minute quantities of transuranium isotopes produced in low-yield thermonuclear explosions. Operating on a batch-feed basis, the plant can process 5 kg of ground rock and isolate the actinide-lanthanide fraction in 16 hr, with recovery as high as 90 to 100%. Up to 15 kg can be processed in 24 hr by concurrent operation. Most of the processing equipment

consists of conventional items such as steel drums, propeller-type mixers, chemical pumps, and tube- and bath-type heat exchangers, all modified for use with corrosive chemicals and for remote operation in shielded cells. The process consists of an acid leach with combined HF and HCl, liquid-liquid extraction into di(2-ethylhexyl)pyrophosphoric acid, hydrolysis of the pyrophosphoric acid, back extraction into an HCl-Fe(III) solution, and concentration by evaporation. (auth)

4720 HIGHLY SELECTIVE METHOD FOR DETERMINING ZIRCONIUM AND HAFNIUM WITH DIANTIPYRYLMETHANE. Zhivopistsev, V. P.; Petrov, B. I. (Perm State Univ., USSR). Zh. Anal. Khim., 23: 1634-9(Nov. 1968). (In Russian).

Conditions were studied for the extraction of zirconium and hafnium with diantipyrylmethane and its alkyl gomologues in the presence of nitrates. It was shown that the best extracting agent is diantipyrylmethane. It was established that from nitric acid media chloroform and dichloroethane extract complexes of the type of ammonium salts $(DH)_2[Zr(NO_3)_6]$ and $(DH)_2[Hf(NO_3)_6]$. A method was developed for the determination of zirconium (hafnium) in materials containing rare earths, Sc, Th, U, Ti, Mo, Fe, Pb, Co, Ni, Hg, Ga, In, and other elements. A simultaneous determination of zirconium and thorium from a single sample is possible when a mixture of diantipyrylmethane and diantipyrylmethylmethane is used for the extraction. (auth)

4721 CATION-EXCHANGE SEPARATION OF SCANDIUM FROM THE RARE-EARTH ELEMENTS. Orlandini, K. A.; Korkisch, J. (Argonne National Lab., Ill.). Separ. Sci., 3: 255-63(June 1968).

From certain organic solvents containing organic phosphorus compounds such as trioctylphosphine oxide (TOPO), bis(2-ethylhexyl)orthophosphoric acid (HDEHP), or tri-n-butylphosphate (TBP) and hydrochloric acid, scandium is much less retained on the strongly acidic cation-exchange resin Dowex 50 than are all other members of the rare earth group. Thus on this resin in a medium which is 95% tetrahydrofuran, 5% 6 M hydrochloric acid, and 0.1 M TOPO, the separation factor for scandium-rare earths is greater than 4×10^3 (corresponding to distribution coefficients of <1 for scandium and $>4 \times 10^3$ for all the other rare-earth elements). By the use of this system a complete and highly effective separation of tracer and macro quantities of scandium from the rare earths can be achieved on a column of this exchanger. Among the organic solvents investigated, tetrahydrofuran gives the best results. The effectiveness of the organic extractants increases in the order TBP < HDEHP < TOPO. (auth)

4722 CARRIER-FREE SEPARATION OF ^{210}Po FROM NEUTRON-IRRADIATED BISMUTH. Inarida, Mariko; Otsuka, Hideko (Inst. of Physical and Chemical Research, Tokyo). Rika Gaku Kenkyusho Hokoku, 44: 186-8(July 1968). (In Japanese).

To separate carrier-free ^{210}Po from neutron-irradiated Bi, a sample of neutron-irradiated bismuth oxide was dissolved in 3 M HCl. After tellurium(IV) carrier was added, the solution was treated with a 10% stannous chloride solution to precipitate Te. A trivial amount of Po in the solution was carried by the Te precipitate. The precipitate was filtered, washed with 3 M HCl, and then dissolved in HNO_3. The resulting solution was evaporated to dryness on a water bath. The residue was dissolved in 0.3 M HCl and the pH of the solution was adjusted to 1 to 2. The solution was shaken with a solution of 0.2 M TTA-TBP to effect the extraction of Po into the TBP phase. Finally, the organic phase was shaken with a solution of HNO_3-HCl (3 : 1 by volume) to accomplish the transfer of Po to the aqueous solution. The recovery efficiency was about 95%. A carrier-free product of Po with sufficiently high radiochemical purity was obtained by this procedure. (NSA of Japan)

4723 POSSIBILITIES AND RESULTS IN THE REPROCESSING OF IRRADIATED NUCLEAR FUELS. Zuehlke, Peter (Geschaeftsfuehrer der Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen mbH, Linkenheim, Ger.). At. Strom, 14: No. 6, 84-7(June 1968). (In German).

Since fissionable material produced in reactors is not completely burned up, the residue is processed for economic reasons. The reprocessing is carried out by wet methods commercially. The development of dry and pyrometallurgical methods is described. The possibilities and costs of the reprocessing are affected by factors such as enrichment, burn-up, and construction of the irradiated fuel element. The reprocessing program and the transport between reactor and processing installation merit special consideration. (tr-auth)

4724 RAPID RADIOCHEMICAL SEPARATION OF SELENIUM. McGee, T.; Lynch, J.; Boswell, G. G. J. (Univ. of Salford, Eng.). Talanta, 15: 1435-9(Dec. 1968).

A rapid separation of selenium based on the extraction of Se(IV) from 4M hydrobromic acid into benzene containing 1% of phenol is described. Recoveries of 99% are achieved in less than 5 min. Oxidizing and reducing agents interfere. The separation is highly selective for selenium, and is suitable for use in the study of short-lived Se isotopes. (auth) (UK)

4725 SEPARATION OF SCANDIUM BY ANIONIC LIQUID–LIQUID EXTRACTION FROM SULFURIC ACID–AMMONIUM SULFATE MEDIUM USING A HIGH MOLECULAR WEIGHT AMINE. Shimizu, Tsuneo (Gunma Univ., Japan). Bunseki Kagaku, 17: 1187-92(Oct. 1968). (In Japanese).

The behaviors of the rare earths, Sc, Th, U(VI), Zr, and Yt in extraction from a $H_2SO_4-(NH_4)_2SO_4$ medium with a high molecular weight amine, Amberlite LA-2, in xylene solution were studied, and a simple and rapid method by an anionic liquid-liquid extraction, with the amine xylene solution was investigated for the separation of Sc from the rare earths, Yt, and many other metal ions. Mutual separation of La, Sc, U(VI), and Zr by the extraction method is also described. Scandium, Th, U(VI), and Zr are extracted quantitatively into the LA-2 xylene solution from 0.1 M H_2SO_4-0.01 M $(NH_4)_2SO_4$ solution, while Al, Cd, Co, Cu, Ga, Mg, Mn(II), Ni, the rare earths, and Yt are not. By the extraction from 0.1 M H_2SO_4-0.01 M $(NH_4)_2SO_4$ solution, Sc can be separated completely from those nonextractable cations but incompletely from In, Fe(III), and V(IV). Scandium in the LA-2 xylene solution is stripped by a back-extraction with 1 M sulfuric acid along with Th, while U(VI) and Zr remain in the LA-2 xylene solution. A successive back-extraction with 5 M HCl and 10% Na_2CO_3 solution strips mutually Zr and U(VI) from the LA-2 xylene solution. Thorium behaves like Sc. (NSA of Japan)

4726 PROCESS FOR PROCESSING IRRADIATED CERAMIC REACTOR FUELS. Wurm, Joseph Gerard; Avogadro, Alessandro (to EURATOM). U. S. Patent 3,399,977. Sept. 3, 1968. Priority date June 10, 1964, Germany.

Irradiated ceramic reactor fuels, having an oxide base, are digested in a molten basic alkali compound such as NaOH, KOH, or mixtures of these, in the presence of air or an oxygen-releasing agent, at a temperature of 500 to 700°C. The insoluble alkali uranate precipitate is separated from the melt and after successive treatments with $K_2S_2O_7$ and NH_3, uranium oxide is recovered. The initial melt containing fissile by-products can be readily converted to insoluble solid materials for ultimate disposal. (Offic. Gaz.)

4727 ^{99m}Tc. (to Union Carbide Corp.). British Patent 1,131,910. Oct. 30, 1968. Priority date Jan. 17, 1967. United States.

A process for producing pharmaceutically pure ^{99m}Tc comprises extracting the ^{99m}Tc from a mixture of ^{99}Mo and ^{99m}Tc in an aqueous concentrated carbonate solution with a ketone; drying the solution containing the ^{99m}Tc by contacting the solvent with a drying agent; evaporating the organic solvent leaving the ^{99m}Tc in the residue; and taking up the residue in a liquid, such as an isotonic saline solution. (B.L.M.)

4728 IMPROVEMENTS IN AND RELATING TO A LIQUID–LIQUID EXTRACTION PROCESS. Grieneisen, Andre (to Commissariat a l'Energie Atomique). British Patent 1,131,578. Oct. 23, 1968. Priority date Mar. 8, 1966, France.

A process for extraction of an element contained in an aqueous solution consists of a primary stage of extraction of the element into a first organic solvent stream followed by washing the loaded organic solution with an aqueous solution and a secondary stage of extraction in which the element is carried over with the aqueous washing solution into a second organic solvent stream followed by recycling of the aqueous washing solution to the primary extraction stage together with the aqueous solution to be processed. The process is described for particular application to the TBP extraction of U and Pu from reactor fuels. (B.L.M.)

4729 METHOD OF DECOMPOSING A NUCLEAR FUEL IN A FUSED SALT SYSTEM BY USING NITRIC OXIDE. Vogg, Hubert H.; Baehr, Werner; Ochsenfeld, Wilhelm (to Gesellschaft fuer Kernforschung mbH). U. S. Patent 3,393,981. July 23, 1968. Priority date Aug. 8, 1964, Germany.

A nuclear fuel is decomposed by heating in an alkaline salt system containing an oxidizing agent, obtaining a cooled melt, leaching the cooled melt with water and/or caustic soda solution, and treating the fuel remaining after the leaching with acid to dissolve the fuel and leave the fission products as residue. The pH of the melt is maintained at a value ranging from weakly acid to alkaline by introducing NO into the melt. (Offic. Gaz.)

4730 METHOD FOR REMOVING LANTHANIDES AND TRIVALENT ACTINIDES FROM AQUEOUS NITRATE SOLUTION. (to United States Atomic Energy Commission). British Patent 1,130,044. Oct. 9, 1968. Priority date Feb. 28, 1966, United States.

Lanthanides and trivalent actinides may be removed from aqueous solutions containing a nitrate salt by contacting the solution with an organic solution of a quaternary ammonium nitrate or chloride containing 17 to 49 C atoms and separating the resulting lanthanide and actinide-containing organic solution from the depleted aqueous solution. The aqueous solution must be 0.01 to 1.5N HNO_3 and 0.5 to 5.0N with respect to the nitrate salt. (B.L.M.)

4731 METHOD OF TREATING COATED-PARTICLE NUCLEAR-REACTOR FUELS. Knacke, Ottmar; Laser, Manfred; Merz, Erich; Riedel, Hans-Juergen (to Kernforschungsanlage Julich des Landes Nordrhein-Westfalen-e.V). U. S. Patent 3,403,985. Oct. 1, 1968. Priority date June 10, 1965, Germany.

A method is described for recovering components of coated-particle nuclear-reactor fuels containing UC as the nuclear-fuel element coated with pyrolytic C, SiC, ZrC, Be_2C, Al_2O_3, BeO, or ZrO_2, in which the coated particles are reacted with a nonaqueous inorganic melt of NaOH or Na_2O_2 at a temperature between 350 and 600°C (preferably about 450°C). The melt contains between 25 and 70 wt % of a higher oxide (BaO_2, Na_2O_2 or K superoxide). Oxygen is introduced into the melt during the solution, and the melt is granulated thereafter. (Offic. Gaz.)

4732 METHOD FOR PRODUCTION OF DEUTERATED METHANES AND HEAVY WATER. Pogorski, Louis A. (to British American Oil Co., Ltd.). U. S. Patent 3,399,967. Sept. 3, 1968. Filed Dec. 13, 1963.

A method is described for efficiently and economically recovering deuterated methanes from natural gas, artificial gas mixtures, coke oven gas, producer gas, and industrial off gases that contain methane. The deuterated methanes are concentrated by liquefaction and low-temperature fractionation of the gas mixtures under conditions resulting in an increased separation factor between the deuterated methanes and ordinary methane as compared with its value at ~ atmospheric pressure. The separation factor is enhanced by proper adjustment of the operating conditions, such as temperature and pressure. The intramolecular forces of the system may be modified to increase the separation factor by the introduction of additives, inducing polarization, or selectively introducing energy into the system. Heavy water may also be produced by the oxidation of deuterated methanes. (B.L.M.)

4733 METHOD FOR FLUORIDATION OF NUCLEAR FUEL BY MEANS OF GASEOUS CHLORINE TRIFLUORIDE. (to Centre D'Etude De l'Energie Nucleaire). British Patent 1,129,855. Oct. 9, 1968. Priority date June, 15, 1965, Luxembourg.

A nuclear fuel containing at least one oxide and fission products is fluorided by being subjected in compact form to the action of gaseous ClF_3 at a temperature of 25 to 300°C. If the fuel contains uranium oxide, Pu, and fission products, fluorination at an initial temperature not exceeding 200°C will transform the uranium oxide into volatile UF_6, and then fluorination at a higher temperature, but not exceeding 500°C will transform the Pu into volatile PuF_6, with the major part of the fission products remaining in the residue. (B.L.M.)

4734 METHOD OF SEPARATION OF THE BORON ISOTOPES. Chemla, Marius; Dirian, Gregoire; Perie, Jacquer; Perie, Michele (to Commissariat a l'Energie Atomique). British Patent 1,129,778. Oct. 9, 1968. Priority date June 21, 1966, France.

Boron-11 and boron-12 can be separated by passing countercurrently in a column a solution of a boric ester in vapor form and a borate of a volatile base in solution. The borate is hydrolyzed at the bottom of the column to liberate the volatile base and also the boric acid, which reacts with the alcohol present to yield a boric ester. The boric ester is condensed at the upper end of the column together with the volatile base. With the addition of water, the boric ester is saponified to the borate of the base, which is returned to the column. The boric ester is preferably methyl borate, and the volatile base is diethylamine. (B.L.M.)

4735 PRODUCTION OF HIGH-PURITY RADIOACTIVE ISOTOPES. Lieberman, Ephraim; Gennill, Wayne Joseph Sr. (to Union Carbide Corp.). British Patent 1,131,546. Oct. 23, 1968. Filed June 8, 1966.

A method is described for the preparation of ^{99}Mo and ^{99m}Tc and for separating the two isotopes. A Mo-containing material is irradiated in a neutron flux until the desired amount of ^{99}Mo is formed. The irradiated material is then dissolved in a base, and the pH of the solution is adjusted to be acidic and above pH 2.5. The solution is then contacted with an inorganic anion exchange material to load the Mo on the exchange material, and then the ^{99m}Tc formed by the radioactive decay of the Mo is eluted from the loaded exchanger with an acid. (B.L.M.)

4736 CATION-EXCHANGE SEPARATIONS IN ORGANIC SOLVENT-DITHIZONE MEDIA. Orlandini, K. A.; Korkisch, J. (Argonne National Lab., Ill.). Anal. Chim. Acta, 43: 459-63 (1968).

Numerous elements can be adsorbed on a column of the strongly acidic cation-exchange resin Dowex 50 from a mixture consisting of tetrahydrofuran and 1M nitric acid (19:1). These elements include Ag, Cu, Bi, Pb, rare earths, alkaline earth metals, alkali metals, U, Th, Fe, Co, Zn, and Cd; Hg and Sb are not retained and so can be separated from the adsorbed elements. Fractionation of the adsorbed elements can be effected by using as eluent 0.01M dithizone in tetrahydrofuran–1M nitric acid (19:1); the dithizonates of silver, copper, and bismuth are selectively eluted while the other absorbed metal ions are still retained. The technique is suitable for the separation of tracer and macro amounts of elements. (auth)

4737 QUANTITATIVE SEPARATION OF THE ALKALI METALS BY CATION-EXCHANGE CHROMATOGRAPHY WITH BIO-REX 40 RESIN APPLICATION TO SILICATE ANALYSIS. Strelow, F. W. E. (National Chemical Research Lab., Pretoria); Liebenberg, C. J.; Von S. Toerien, F. Anal. Chim. Acta, 43: 465-73(1968).

The application of BIO-REX 40, a phenolformaldehyde resin, to the quantitative separation of Li, Na, K, Rb, and Cs is described. All five elements can be separated in a single procedure by using a 25-g (62-ml) resin column and eluting lithium with 500 ml of 1.00 M hydrochloric acid in 80% ethanol, sodium with 500 ml of 0.20 M hydrochloric acid, potassium with 250 ml of 0.70 M hydrochloric acid, rubidium with another 450 ml of 0.70 M hydrochloric acid, and cesium with 500 ml of 4.0 M hydrochloric acid. Procedures are described for the accurate determination of alkali metals in silicate minerals, plant material, and water. Al, Fe, Ti, Zr, V, Mo, and some other elements are first separated by absorption as oxalato complexes on a column of AG1-X8 resin. The alkali metals are finally determined by gravimetry or atomic absorption spectrometry. Tables of distribution coefficients and quantitative results of analyses of synthetic mixture and standard silicate samples are presented together with typical elution curves. (auth)

4738 STUDIES ON GLASSIFICATION OF PUREX-TYPE WASTE SOLUTION. I. VOLATILITY OF RUTHENIUM. Iwamoto, Kazumi; Kikuchi, Teruo (Japan Atomic Energy Research Inst., Tokai). Radioisotopes (Tokyo), 17: 467-70(Oct. 1968). (In Japanese).

Phosphate glass was prepared by heating the mixture of synthetic Purex 1 WW waste solution and phosphoric, phosphorous, or hypophosphorous acid up to 1100°C, and the volatilization behavior of Ru was studied. The above three glass-forming reagents were effective to the same degree in restricting the volatilization of Ru; about 90% of Ru in the waste solution was retained in the glass. It was made clear that the glass with 65 wt % P_2O_5 would be desirable from the viewpoints of the suppression of Ru vaporization and of the preparation of the glass containing a large amount of waste oxide. (auth)

4739 STUDIES ON GLASSIFICATION OF PUREX-TYPE WASTE SOLUTION. II. LEACHING OF GLASS WITH WATER. Iwamoto, Kazumi; Kikuchi, Teruo (Japan Atomic Energy Research Inst., Tokai). Radioisotopes (Tokyo), 17: 471-5(Oct. 1968). (In Japanese).

The leachability of ^{137}Cs and P from the phosphate glass, which was prepared by heating the mixture of synthetic Purex 1WW waste solution and phosphoric acid (P_2O_5 content in the glass was 65 wt. %) up to 1100°C, was examined with distilled water, tap water, and seawater. The following results were obtained: the leachability of ^{137}Cs with distilled water was less than that with tap water or seawater, but that of P did not depend on the kind of water; the leachability increased remarkably with temperature; and the leaching data were correlated by introducing the initial activation energy spectrum for the reaction between glass component and water. (auth)

4740 PREPARATIVE WORK ON ^{227}Ac AND ITS DECAY PRODUCTS. I. SEPARATION AND MEASUREMENT METHODS. Mueller, Walter A. (Gesellschaft fuer Strahlenforschung mbH, Neuherberg, Ger.). Radiochim. Acta, 9: 181-6(Oct. 1968). (In German).

The behavior of carrier-free ^{227}Ac nitrate in equilibrium with its decay products on anionic and cationic exchange columns was studied. ^{223}Ra, ^{227}Th, and ^{227}Ac could be separated with high radiochemical purity. A special preparation technique was used which allowed the direct measurement of α spectra of the elution fractions by means of a semiconducting detector. The α energy values could be determined with an accuracy of ±1.5 keV. The relative intensities and the radiochemical purity were estimated by analyzing quantitatively the measured spectra. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 4747, 4789, and 5723.

4741 NATURAL THERMOLUMINESCENCE OF CRETACEOUS LIMESTONES IN TERMS OF ALPHA ACTIVITY. Medlin, W. L. (Mobil Research and Development Corp., Dallas). Geochim. Cosmochim. Acta, 32: 1165-76(Nov. 1968).

Thermoluminescent dating of limestones is based on buildup of thermoluminescence due to natural α activity. The method cannot be used in limestones whose thermoluminescence growth has reached saturation. In the investigation described it was considered whether thermoluminescence buildup had reached saturation in typical limestones of Cretaceous age. Natural thermoluminescence was measured in terms of natural α activity in single limestone beds where variations in thermoluminescent properties were negligible. Four beds were selected in which α activity varied by a factor of two or more. Natural thermoluminescence was determined in samples from each bed and plotted against α count; the measurements were made in terms of intensity of the 600°K glow peak. These measurements were normalized with respect to intensity produced by irradiation with a ^{210}Po source. Natural α activity was measured with both scintillation and gas flow proportional counters. Results showed that natural thermoluminescence was independent of α activity in all four beds. This is interpreted to mean that thermoluminescence buildup has reached saturation in average limestones of Cretaceous age. The results also show that growth of the 600°K peak has been influenced by temperature, and saturation has occurred without complete filling of traps. (auth)

4742 STUDY OF THE RADIOACTIVITY LOCALIZED ON AEROSOLS OF PARTICLE SIZE GREATER THAN 0.25 μ. Storebo, P.; Madelaine, G.; Bricard, J. (Laboratories Associes de Physique des Aerosols, Paris). Ann. Occup. Hyg., 11: 295-8 (Oct. 1968). (In French).

It was proved, by direct measurement, that the radioactivity attached to atmospheric particles over 0.25 μ radius, at ground level, may reach 60% of the total radioactivity on natural aerosols; it was also shown that the distribution of natural radioactivity over particle size cannot be deduced from measurements which involve previous artificial enrichment with thoron. (auth)

4743 PRIMENENIE RADIOAKTIVNYKH IZOTOPOV DLYA KONTROLYA ZA RAZRABOTKOI NEFTYANYKH MESTOROZHDENII. (Use of Radioisotopes for Control in Development of Petroleum Deposits). Sokolovskii, E. V. Moscow, Izdatel'stvo Nedra, 1968. 180p.

The theory and use of radioisotopes for the study of structure and control in the development of petroleum deposits were examined. Special attention is given to detecting the peculiarities of the mechanism of replacement of petroleum by water from producing layers. The different methods for prospecting using radioisotopes and the treatment of materials obtained are described. An evaluation was made of the work conditions according to the selection of indicators for tracing the movement of liquid in layers. Dilution of labeled solutions was also investigated. The results of the use of radioisotopes in Grodno areas and in the U. S. are given. (104 references). (tr-auth)

4744 WATER. Radiol. Health Data Rep., 8: 600-4(Oct. 1967).

Data for the radioactivity in raw surface waters for April 1967 are tabulated for 37 rivers in the U.S. The average alpha radioactivity and the average beta radioactivity are given for both suspended and dissolved samples. A summary of the monthly average gross alpha radioactivity and beta radioactivity in Minnesota municipal water supplies for July to December 1966 is also presented. (D.H.M.)

4745 FORMATION OF RADIOCHEMICAL COMPOUNDS IN SOIL WATERS. Ergashev, S. E. (Inst. of Hydrogeology and Engineering, Moscow). Dokl. Akad. Nauk Uzb. SSR, No. 7, 3-4(1968). (In Russian).

The distribution and properties of radioactive elements in the ground waters of one of the artesian basins in an arid region of the USSR were studied. The content of uranium in soil water varied from 5×10^{-7} to 3×10^{-3} g/l. An increased amount was found in some lower regions of the basin in which the load of soil water was heavier and the U content of these underground waters reached 1 to 3×10^{-3} g/l. The waters were highly mineralized with sodium chloride and less-frequently with sodium sulfate-chloride content. (R.V.J.)

Meteorology

Refer also to abstracts 4742, 4756, and 4929.

4746 (ANL/ES-CC-3) CITY OF CHICAGO AIR POLLUTION SYSTEM MODEL. Quarterly Progress Report No. 3. Croke, E. J.; Carson, J. E.; Gatz, D. F.; (and others) (Argonne National Lab., Ill.). Oct. 1968. Contract W-31-109-eng-38. 254p. Dep. CFSTI.

In the Chicago Air Pollution System Analysis Program it was possible to initiate a comprehensive series of analytical studies of local air pollution meteorology and SO_2 dispersion characteristics; formulate and validate tentative SO_2 "prediction" algorithms; and conduct in-depth meteorological case studies of Chicago air pollution episodes, utilizing the data retrieval, sorting, processing and analytical capabilities provided by the master information system. Preliminary tests of multivariate discriminate analysis were conducted in order to evaluate the effectiveness of this technique as an analytical tool, and the development of an urban mixing layer depth computational algorithm was initiated. The experimental program remains in its preparatory stages, but trial runs were made with the modified gas chromatograph to be used in the sulfur hexafluoride tracer studies. A major achievement was the completion of the optimal, incident abatement pilot study, which was conducted with the cooperation of the Commonwealth Edison Company. A computerized, incident control strategy, based on a source-oriented dispersion model and a standard linear programming algorithm, was developed for key stations in the urban power plant network. This strategy automatically generates a minimum cost SO_2 incident abatement plan within the physical, economic and operational constraints normally imposed on the Edison system. A preliminary cost-effectiveness study of a city-wide SO_2 incident abatement strategy, based on total SO_2 emission control, was also completed. The results of this study represent the first attempt to evaluate the economic impact of an incident control operation in Chicago. (L.C.L.)

4747 (NP-17498) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 6, Number 2. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). Feb. 1968. 45p. Dep. CAN.

Results from the collection and analysis of human bone samples for ^{90}Sr are presented. Analyses of air, precipitation, milk, water, wheat, soil, and human bones for fallout were carried out and results are presented for January, 1968. Environmental monitoring studies at Canadian reactors are reported. (M.C.G.)

4748 (NP-17505) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 6, Number 3. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). Mar. 1968. 30p. Dep.

Regulatory controls in the use of radioisotopes are discussed. Fallout measurements in air, precipitation, and milk in February 1968 are presented along with reactor environment monitoring data for the same period. (M.C.G.)

4749 (NP-17653) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 6, Number 5. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). May 1968. 24p. Dep.

Fallout in air, precipitation, and milk for April 1968 is reported. Data from reactor environment monitoring for the same period are included. (M.C.G.)

4750 SOME NOTES ON FORECASTING OF WINDS ALOFT BY STATISTICAL METHODS. Reed, Jack W. (Sandia Corp., Albuquerque, N. Mex.). J. Appl. Meteorol., 6: 360-72(Apr. 1967).

Winds aloft statistics from Eniwetok were used to derive a linear regression forecast technique that verified satisfactorily in later application. Other studies showed that these principles were applicable throughout the tropical Pacific Ocean area. Time-lag correlation coefficients were found to decay exponentially with increased time except in the first 6 hr, when decay was more rapid. This has been interpreted as the effect of measurement error and small-scale turbulence. A method was derived for removal of these random errors and, on application, time-lag correlation coefficients for each altitude were then found to decay

at constant exponential rates, to at least 48 hr. This indicates that no improvement in regression forecasting can be achieved by use of multiple-term regressions from sequential data. Also, regression forecast verifications can be significantly improved by removing the instrument error by hardware techniques and smoothing out small-scale turbulence by multiple observation. This general technique is also shown to be useful in forecasting for other latitudes but comparison with other forecast methods for middle and high latitudes has not been made. (auth)

4751 OTHER DATA. Radiol. Health Data Rep., 8: 613-20 (Oct. 1967).

Results from environmental monitoring around nuclear facilities are reported. Data from Bettis Atomic Power Laboratory, Knolls Atomic Power Laboratory, and SIC Prototype Reactor Facility for July to December, 1966 are included. Data on reported nuclear detonations during September, 1967 are also presented. (D.H.M.)

4752 AIR AND DEPOSITION. Radiol. Health Data Rep., 8: 605-12(Oct. 1967).

Surveillance data for June 1967 on radioactivity in airborne particulates and precipitation are reported from the programs of the U.S. Public Health Service, the Canadian Department of National Health and Welfare, the Mexican Commission of Nuclear Energy, and the Pan American Health Organization. (D.H.M.)

4753 EXPERIMENTS WITH A STRATOSPHERIC GENERAL CIRCULATION MODEL. II. LARGE-SCALE DIFFUSION OF TRACERS IN THE STRATOSPHERE. Hunt, Barrie G. (Weapons Research Establishment, Salisbury, Australia). Mon. Weather Rev., 96: 503-39(Aug. 1968).

Study of the diffusion of two idealized tracers in the stratosphere by means of a previously described 18-level primitive equation general circulation model. One tracer was designed to simulate broadly the behavior of the radioactive tungsten which escaped into the stratosphere following nuclear tests in the tropics, while the other was taken as a photochemical ozone distribution. The large-scale eddies were of primary importance for the poleward transport of the tracers in middle and high latitudes, but the supply of tracer for these eddies was principally maintained from the higher levels by the downward branches of the meridional circulation. The synoptic situation in the atmosphere was found to be of fundamental importance for the large-scale diffusion of the tracers in the middle latitudes, and the down-gradient transport of tracers in the lower stratosphere was primarily accomplished by the upper-level troughs of the planetary-scale wave system. (IAA)

Oceanography

4754 RATES OF VERTICAL EDDY DIFFUSION NEAR THE OCEAN FLOOR BASED ON MEASUREMENTS OF THE DISTRIBUTION OF EXCESS ^{222}Rn. Broecker, W. S.; Cromwell, J.; Li, Y. H. (Columbia Univ., Palisades, N. Y.). Earth Planet. Sci. Lett., 5: 101-5(Oct. 1968).

Measurements of the concentration of radon gas in near bottom water provide a means of estimating the rate of vertical mixing in the deep sea. Radon diffusing from the pore waters of deep sea sediments resides in the water column an average of five and one-half days before undergoing radiodecay. The thickness of the water column over which this radon distributes itself depends therefore on the rapidity with which the deep water mixes. Assuming that vertical mixing is accomplished by eddy diffusion results from 9 profiles widely distributed over the world ocean show a range of coefficients from 2 to 50 cm^2/sec. (auth)

4755 PROTECTION AGAINST RADIOACTIVE CONTAMINATION OF SEA. Ichikawa, Ryushi (National Inst. of Radiological Sciences, Tokyo). Hoken Butsuri, 3: 317-26(Sept. 1968). (In Japanese).

In view of the rapid increase of nuclear energy facilities e.g., power plants, fuel-reprocessing plants etc., the safe control of the disposal of radioactive wastes into the sea has been and will be of great concern in the world. The historical background information of radioactive contamination of the sea due to the past military use of atomic energy, natural and artificial radioactivity in the sea, general features of the behavior of radioactive nuclides in marine environments, safe management of coastal discharge of radioactive liquid wastes, disposal of solid radioactive wastes into deep sea bottom, and the problem of international control of radioactivity release in marine environments are discussed. (NSA of Japan)

Seismology

Refer to abstracts 4758 and 4793.

ENGINEERING

Nuclear Explosions

Refer also to abstracts 4719, 4751, and 5328.

4756 (PNE–715–F) FINAL REPORT OF OFF-SITE SURVEILLANCE FOR PROJECT SULKY. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Mar. 9, 1965. 14p. Dep. CFSTI.

The Public Health Service provided off-site surveillance for Project Sulky which was conducted at 1135 hours on December 18, 1964. The highest gamma dose rate recorded off-site was 0.06 mr/hr and no fresh fission products were detected in air, water or milk samples collected subsequent to this event. No exposures exceeded the radiological safety guides set forth in the AEC Manual Chapter 0524. (auth)

4757 (PNE–718–F) FEDERAL AVIATION AGENCY AIR-SPACE ADVISORY. PROJECT SULKY. Final Report. Vick, H. M. (Federal Aviation Agency, Palmdale, Calif. Los Angeles Air Route Traffic Control Center). Aug. 5, 1966. 8p. Dep. CFSTI.

The object of the study was to delineate a sector through which a contaminated air mass is expected to move and through which nonparticipating military and civilian aircraft would be advised not to fly. The Federal Aviation Agency concluded that the Project Sulky Air Space Advisory Plan provided all proper precautions necessary to ensure against radioactive contamination of airmen or aircraft. (R.C.K.)

4758 (UCRL–50486) FROZEN EARTH MATERIALS AS SEISMIC DECOUPLING MEDIUMS. Butkovich, T. R. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 26, 1968. Contract W-7405-eng-48. 18p. Dep. CFSTI.

The SOC computer code, designed to calculate the effects of detonations of contained explosions on the surrounding medium, was used to calculate a source function called the reduced displacement potential. The input to the code was an experimentally determined equation of state for each of the following frozen earth materials (at −10°C): dry and ice-saturated sand, partially and fully ice-saturated glacial till, and ice. The reduced displaced potential was convolved with the response of the Benioff seismometer and appropriate attenuation operators. The first half-cycle displacement amplitudes at 300 and 500 km were compared to those obtained from particle velocity measurements for nuclear events in four mediums. These results, scaled to 5 kt and normalized to tuff, are: tuff 1, granite 2.43, salt 2.63, and alluvium 0.18, for actual nuclear events; and ice 0.78, 100% saturated sand 0.56, 100% saturated till 0.67, and 57% saturated till 0.33, for simulated nuclear events in these mediums. The latter value for partially saturated till assumed a compressional velocity of 2400 m/sec for the medium. A lower assumed velocity reduces the values. (auth)

4759 (UCRL–50506) THE FLIP CODE: FLUID INJECTION PROGRAM. Korver, J. A. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 15, 1968. 32p. Dep. CFSTI.

The FLIP code is a computer-program solution to the time-dependent flow of an incompressible fluid from large diameter wells into unsaturated, confined formations. A continuous succession of steady-state solutions is used to predict the nonsteady flow behavior in time and space. With reasonable assumptions for the initial conditions, running times for problems of interest can be as short as 5 to 10 seconds. (auth)

4760 CAN NUCLEAR RETORTING UNLOCK OIL SHALE. Eng. Mining J., 168: 72-5(Dec. 1967).

Project Bronco, a nuclear blast in Colorado oil shale to demonstrate the feasibility of underground fracturing and in-place retorting, is discussed. The tentative site on government-owned oil shale land in the Piceance Creek Basin contains as much as a 2000-ft thick oil shale horizon. Dawsonite ($NaAlCO_3(OH_2)$), nahcolite ($NaHCO_3$), and halite, potential by-product sources of soda ash and alumina that have only recently been identified in the Green River structure, are commingled with oil shale in the relatively impermeable lower zone of the Parachute Creek member. The lower zone is overlain by a leached, water-bearing zone of oil shale. A nuclear explosive with a yield of about 50 kt is anticipated for Bronco. The assumed depth of emplacement at 3350 ft is considered more than adequate to ensure containment of the explosive energy. The nuclear device would create a collapse chimney 230 ft in dia which would extend to a height of 520 ft. Fractures caused by the explosion would extend as much as 460 ft laterally beyond the collapse zone and as far as 700 ft above the shot point. The upper level of the fracture zone would be about 2650 ft underground. Most of the radioactive materials resulting from the explosion would condense, cool, and solidify in a glassy puddle at the bottom of the cavity. The chimney rubble would contain a bulk porosity of about 25% and as much as 1 Mt of fragmented oil shale. If the average oil content were 24 gal/ton, the chimney itself would contain more than 600,000 bbl of oil. The proposed experiment is to be staged in 4 phases: evaluation of the proposed site from a technical and safety point of view; construction to prepare the nuclear explosion, the detonation, and postshot evaluation; chimney retorting; and an attempt to extend the retorting process to a portion of the fractured zone surrounding the chimney. (BBB)

4761 COMPREHENSIVE TEST BAN. Davies, David (Cambridge Univ., Eng.). Sci. J., 4: No. 11, 78-84(Nov. 1968).

A major obstacle to a comprehensive nuclear test ban has been the inability to monitor underground explosions without territorial intrusions. Recent seismic evidence, showing much improved capabilities for distinguishing explosions from earthquakes, may open the way for further political negotiations. (auth)

4762 NUCLEAR EXPLOSIONS. Kothari, D. S. Sci. Cult. (Calcutta), 34: 268-79(July 1968).

A brief history of nuclear energy is presented with emphasis on the development of nuclear explosion capabilities of countries around the world. Tabulated data show the relative nuclear destructive power of major nations, and the cost of their nuclear weapons development. The political considerations necessary for restraining the nuclear arms race are discussed along with the advantages and shortcomings of the Non-Proliferation Treaty. It is concluded that the solution to the great nuclear challenge of our times can be found only on the basis of hope and faith, trust and confidence, courage and wisdom, and that the only possible goal can and ought to be comprehensive and complete disarmament. (L.C.L.)

Facilities and Equipment

Refer also to abstracts 5334 and 5355.

4763 (BARC–347) HIGH EFFICIENCY AIR CLEANING AND FILTER TESTING. Khan, A. A. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 21p. Dep.

Uses of high efficiency filters, the mechanism of filtration, filter materials, modern air filters, filter installation, filter testing, and economics of high efficiency filtration are discussed. (W.H.K.)

4764 IMPROVEMENTS IN WELDING. Moir, John Duncan (to United Kingdom Atomic Energy Authority). British Patent 1,134,706. Nov. 27, 1968. Filed May 10, 1966.

Improvements in dc electric arc welding are described. A capacitor is used as an auxiliary source of unidirectional welding current in addition to a dc power source. The method is used in welding stainless steel fuel elements in helium atmospheres. (F.S.)

4765 METHODS AND APPARATUS FOR UNDERWATER IRRADIATION OF SUBSTANCES. Blache-Fraser, F. M. S.; Cowper, D. R.; Curnow, E. K. (to Atomic Energy of Canada, Ltd.). Canadian Patent 789,661. July 9, 1968.

A radioactive source such as ^{60}Co is placed in tubes at the bottom of a tank of water of sufficient depth to shield personnel working at the surface level. Substances to be irradiated are placed around the periphery of a hollow inverted bell. The bell with trapped gas is forced to the bottom of the tank so that the radioactive source now occupies a central position in the bell with the substances to be irradiated in containers about the inner circumference. Water does not enter the bell because of trapped gas which may be changed as it becomes ionized. A motor rotates the containers within the bell so uniform radiation of all parts is attained. Suitable lowering and raising mechanism for the bell is provided. (F.S.A.)

4766 MEASUREMENT OF VELOCITY AND TEMPERATURE OF LIQUID METAL COOLANT. Subbotin, V. I.; Ibragimov, M. Kh.; Loginov, N. I. At. Energ. (USSR), 25: 150-1(Aug. 1968). (In Russian).

The variations in flow and temperature of a liquid metal coolant through a reactor core can be readily measured by an electromag-

netic method in conjunction with the use of microthermocouples. The small magnet was put on the tube diameter with its axis perpendicular to the motion of the liquid metal. The signal sensitivity was 100 μV at a velocity of 1 m/sec. The absolute value of the signal was found to be proportional to the average velocity of the liquid metal in channels of complicated form (banks of rods, annular spaces etc.). The change in magnitude of the signal gave a qualitative picture of the flow distribution along the cross-section of the channel. The method of measurement does not introduce any hydrodynamic perturbations. Pulsating flow can be followed due to the inertness of the method. The electrodes of the flow meter can also be used as the temperature electrodes of the thermocouple. The instrument is of simple reliable construction, and can be used in actual reactors having a liquid metal coolant. (TTT)

4767 FOOD IRRADIATION. Huff, John B. (Bureau of Commercial Fisheries Technological Lab., Gloucester, Mass.). Isotop. Radiat. Technol., 6: 154-63(Winter 1968-69).

A comparison of data on ^{60}Co use in the Marine Products Development Irradiator shows that using an 8-ft source instead of a 4-ft source will result in lower costs. Using ^{137}Cs instead of ^{60}Co may reduce costs, depending on price changes. A technique is described that uses a point source to simulate an annular source. A simple compact irradiator for shellfish is described; cost data show that irradiation will cost about 1.6 cents/lb under typical conditions. (auth)

4768 A JAW CRUSHER FOR PLUTONIUM CERAMICS. Ayer, J. E. (Argonne National Lab., Ill.); Osuna, H. Nucl. Appl., 5: 417-23(Dec. 1968).

Statistical analysis of test results obtained by crushing SiC and ZrO_2 yielded the optimum design characteristics for a miniature jaw crusher. The device was needed to reduce subcritical amounts of plutonium ceramics to sizes suitable for reactor use. Tests were conducted using a prototype jaw crusher in which crushing speed, jaw clearance, jaw angle, ratio of feed size-to-jaw clearance, and feed rate could be varied. A crusher built with the optimum design characteristics crushed $(U,Pu)O_2$ to the particle-size distribution that was predicted and desired. (auth)

4769 PERFORMANCE OF MODEL 7FE CHARCOAL FILTER FOR THE REMOVAL OF AIRBORNE RADIOIODINE. I. IN-PLACE TEST FOR THE DESIGN OF AIR CLEANING SYSTEM AT ^{131}I PRODUCTION FACILITIES. Naritomi, Mitsuo; Fukuda, Seiji (Japan Atomic Energy Research Inst., Tokyo). Hoken Butsuri, 3: 339-47(Sept, 1968). (In Japanese).

In order to obtain data useful for the design of an air cleaning system at iodine-131 production facilities, the Model 7FE charcoal filter installed in the exhaust air cleaning system at the Test Production Plant, JAERI, was examined for performance for the removal of airborne radioiodine by using the airborne iodine-131 discharged into the exhaust system during processing. The iodine-131 concentration ranged from 10^{-5} to 10^{-8} μCi/cc. The results obtained are summarized as follows: removal efficiency over a period of 30 min at any time after the start of processing decreases with time, due to the increasing desorption of iodine; i.e., it maintains 97% on the average from the start to the first 2 hr independently of the relative humidity of the exhaust air, whereas from 8 hr after the start it decreases from about 95% to about 5% as the relative humidity is increased; removal efficiency as determined for long periods more than 5 hr after the start of processing depends greatly on the relative humidity; i.e., at relative humidity of less than 50% the removal efficiency over 24 hr after the start exceeds 90%, whereas at relative humidity of more than 70% it decreases to 85%. By installing the model 7FE charcoal filter in place of an absolute filter, an amount of iodine-131 discharged from the stack is reduced to $\frac{1}{20}$ on the average; and no appreciable deterioration of the performance for the removal of airborne iodine-131 was found through one year of continuous exposure to exhaust ventilation air from the Iodine-131 Test Production Plant. (NSA of Japan)

4770 ELECTRON IRRADIATION DEVICE. Arakawa, Kazuo (to Matsushita Electric Industrial Co., Ltd.). Japanese Patent 1968-17360. July 22, 1968. Filed Dec. 15, 1964.

An electron irradiation device with deflection scanning is described whereby the electron rays can be made vertical to the surface of materials in the whole field of scanning and the irradiation intensity distribution can be uniform. To produce the vertical (and parallel) electron rays over the whole scanning field, a coil or an electromagnet is installed in the passage of scanned electron rays, which is excited by a current of the same wave shape as the scanning coil, and which gives a deflection angle opposite to that of the scanning deflection. The field of magnetic action by the coil or electromagnet is made concave or convex in the plane formed by the scanned electron rays to obtain both a uniform irradiation intensity distribution over the whole irradiation field and the vertical (and parallel) electron rays. (NSA of Japan)

Heat Transfer and Fluid Flow

Refer also to abstracts 4759 and 4766.

4771 (GEAP-5679) TWO-PHASE FLOW AND HEAT TRANSFER IN MULTIROD GEOMETRIES. Eleventh Quarterly Progress Report, April 1-June 30, 1968. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Aug. 1968. Contract AT(04-3)-189. 22p. Dep. CFSTI.

A description of the relationship between the mean liquid film flow rate and the mean liquid film thickness for annular adiabatic two-phase flow is presented. Data are presented for different fluids and different geometries. Good agreement is established for the G^+ versus δ^+ relationship for pressures of 1 atm < P < 22 atm, $0.05 < x < 0.74$, and mass flow rates between 0.1×10^6 and 2×10^6 16/hr ft^2. An analysis using mixing length theory with void allowance is in agreement with the data. A comparison of the data indicates the Levy model for liquid film thickness is relatively insensitive to the film liquid flow rate. (20 references are included) (D.C.C.)

4772 (NYO-3679-6) HEAT TRANSFER AND HYDRAULICS: THE EFFECTS OF SUBCOOLED VOIDS. Sixth Quarterly Report, July-September 1968. Staub, F. W.; Walmet, G. E.; Niemi, R. O. (General Electric Co., Schenectady, N. Y. Research and Development Center). Sept. 1968. Contract AT(30-1)-3679. 72p. (EURAEC-2075). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

An experimental and analytical program directed toward the determination of the void distribution, location of the initiation of net vapor generation, pressure drop, and heat transfer coefficients in subcooled boiling water systems is discussed. The measurement of the initiation and early development of the subcooled void profile will be carried out, including all required profile measurements and observations, with low-pressure water. The void profile and the pressure drop and heat transfer measurements will be extended to a reduced pressure range of 0.1 to 0.7 and the higher quality regions, using the Refrigerant -22 facility. The void profiles, pressure drop, and heat transfer coefficients will be measured at a reduced pressure of about 0.4 to 0.5 in. water to provide a check on the formulation previously arrived at. All water experiments will be conducted with and without a reactivity and a pH control additive to determine their effect at both low and high pressures. The objectives of the analytical effort are to derive general equations which accurately predict the void fraction, pressure drop, and heat transfer coefficients in two-phase flow with subcooled boiling for various fluids and over a wide range of operating condition. Emphasis will be placed on the formulation of the point where net vapor generation is initiated, in subcooled boiling, in terms of the surface and fluid properties, local geometry, and the operating characteristics of the system. Experimental runs were completed to obtain comparative information without additives at three atmospheres and to check the void profile along the axis prependicular to the heated surface. A total of 80 test runs have been carried out, exclusive of all calibration tests, completing both the original and expanded experimental scope. The analytical method for predicting the net void inception point has been generalized in non-dimensional form. Simplified plots are given that allow rapid calculation of this point for water and Refrigerant-22. A prediction method for the pressure drop in subcooled boiling has also been developed and reported. The values of the distribution parameter and drift velocity obtained under Task I have been determined and their correlation will be reported as soon as further high-pressure data, to be taken under this effort, become available. It has been decided that the present 0.4-in. inner dia, 60-in. test section will provide a greater range of experimental data if the void fraction read-out system is changed to a digital, time-averaged, count rate method. By avoiding the need for a test section with a larger diameter, the mass velocities of interest to this investigation can be obtained. Nineteen test runs have been completed between 100 and 1000 psia, covering mass velocities to 2×10^6 lbs/hr/ft^2. These included tests with water only, with a reactivity control agent, and with both reactivity and pH control agents. Void fraction profiles, pressure drop, and surface temperature measurements were carried out. The data reduction procedures are complete and are reported. Code programming is being debugged and data reduction will follow. (auth)

4773 (RT/ING–(68)-15) THEORY OF LIQUID–GAS TWO-PHASE FLOW. PART II. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 99p. (In Italian). Dep.

A study was made to show that thermohydrodynamic instabilities, such as burn out, and the various two-phase flow patterns can be physically interpreted and analytically described on a thermodynamic basis, if the compressibility and the thermal expansion of the fluid are taken into account. The exact theoretical equations which make it possible to determine the critical flow conditions are derived and compared with the experimental results. In the first part of the study, the present status of fluid mechanics and vibration theory were examined with the aim of evaluating the limits of their validity, in the case of diabatic and two-phase flows. In this second part, similarities of permanent and periodic flow are pointed out and the general conditions for stability and instability are found. The need for two new concepts for a correct analysis of flow phenomena is stressed: (a) thermodynamic cross section and (b) current density; new theories of friction and sonic flow are developed in adiabatic and diabatic conditions; finally the critical values of friction, fluid velocity and enthalpy for transition to periodic flow and thermal instability are determined and discussed. (auth)

4774 EFFECT OF TUBE ROW NUMBER ON THE PRESSURE DROP AND HEAT TRANSFER OF BUNDLED TUBES AT HIGH REYNOLDS NUMBERS. Scholz, F. (Kernforschungsanlage, Juelich, Ger.). Chem.-Ing.-Tech., 40: 988-95(Oct. 25, 1968). (In German).

The effect of tube row number on heat transfer and pressure loss at Reynolds numbers between 10^4 and 10^6 has been investigated for a staggered arrangement of bundled tubes and for two tapered tube bundles. The results of the investigation show that the individual rows of tubes do not participate to the same degree in the characteristic changes. On the basis of the results, suggestions are made for the construction of heat exchangers having considerably more than ten rows of tubes. (auth)

4775 SIMULATION OF NUCLEATE POOL BOILING. Hanjalic, Kemal (Research and Development Center for Thermal and Nuclear Engineering, Sarajevo, Yugoslavia). Tehnika (Belgrade), 23: 1668-79(Oct. 1968). (In Slovak).

An investigation of nucleate boiling heat transfer was made by means of an experimental analogy. The nucleate boiling was simulated by the bubbling of air through a drilled plate into a pool of distilled water. The purpose of the work was to study the mechanism of the gas bubbling process under nonisothermal conditions and to compare the heat transfer results with those of nucleate boiling. A brief comparative survey of literature, concerning the details of both nucleate pool boiling and gas bubbling at a horizontal surface, is presented. The analysis, based on the principles of the theory of similarity, was applied in an attempt to obtain a more reliable basis for the comparison of heat transfer correlations. A photographic study was made in order to elucidate some details of the mechanism of both boiling and the gas bubbling process. The experiments were carried out with heated drilled metal plates, 18 holes per cm^2 being made by means of a drill and a laser. Data were obtained for heat transfer correlations and also for bubble departure diameter and nucleation sites density. As a reference, a nucleate boiling experiment was conducted under similar experimental conditions. The experiments confirmed the previous observation that the flow structure is the basis for comparison of heat transfer predictions. The theoretical analysis and the study of photographs showed that the discrepancy between boundary conditions in actual and simulated processes caused the difference in flow patterns. The additional terms in the nondimensional heat transfer correlation for simulated pool boiling were proposed to be taken into account. (auth)

4776 APPROXIMATE FORMULAE FOR TEMPERATURE DISTRIBUTION IN A HEAT-GENERATING POLYGONAL CYLINDER WITH A CENTRAL CIRCULAR HOLE. Takeuti, Yoitiro (Tokushima Univ., Japan). Nucl. Eng. Design, 8: 241-6(1968).

Derivation of approximate formulae for temperature distribution in heat-generating polygonal cylinders with a central circular hole and thermally insulated outer boundary using the point matching method is discussed. (auth)

4777 SPOT-INSULATED PLATE. Van Sant, J. H. (Univ. of California, Livermore). Nucl. Eng. Design, 8: 247-50(1968).

The problem of determining temperatures on the surface of a flat plate that is both convectively cooled and insulated by a circular spot is presented. Cases of a uniform internal heat source and a constant-temperature surface heat source are considered. The results of a numerical solution show the increase of the temperature under the insulating spot as the Biot number hw/k and the dimensionless spot radius are varied. (auth)

Isotope Technology

Refer also to abstracts 4753, 4767, 4797, and 4851.

4778 (CONF-670550) PROCEEDINGS [OF THE] SYMPOSIUM ON TOLL ENRICHMENT AND PRIVATE OWNERSHIP, FRANKFURT/MAIN, MAY 2 AND 3, 1967. (Atomic Industrial Forum, Inc., New York. Deutsches Atomforum e. V., Duesseldorf (West Germany)). 165p.

The tape recorded discussions of the papers presented at the first joint symposium of the Atomic Industrial Forum and the Deutsches Atomforum held at Frankfurt/Main on May 2 to 3, 1967 is presented. These proceedings include introductory remarks and discussions of papers, but not the papers prepared for the conference. (L.C.L.)

4779 (CONF-681015–1) POWER OPTIMIZATION FOR GASEOUS DIFFUSION PLANTS. Levin, S. A. (Oak Ridge Gaseous Diffusion Plant, Tenn.). [nd]. Contract W-7405-eng-26. 13p. Dep. CFSTI.

From Symposium on Problems Bearing on Isotope Separation of Uranium, Turin, Italy.

A method for optimizing the distribution of power over the various groups of stages in a gaseous diffusion plant for a given total plant power level is described. The mathematical model that permits the performance of a gaseous diffusion cascade to be determined is presented. A gaseous diffusion cascade is considered to be made up of many sections connected in series. Each section is composed of a number of identical stages and, therefore, within each section the interstage flows and stage separation factors are constant. The sections of a gaseous diffusion cascade are analogous to distillation columns with constant molal reflux and constant relative volatility and their behavior can be predicted mathematically with the use of equations familiar in distillation theory. The iterative procedure used to calculate the productivity of the gaseous diffusion complex, consisting of a series-parallel arrangement of cascade sections is described in detail. The power optimization problem is then treated. It can be described mathematically as finding the maximum of an objective function involving many variables subject to the constraining relationship of fixed total power input. The solution is obtained by Lagrange's method of undetermined multipliers. In order to employ this method, it is first necessary to relate the interstage flow and separation factor to the stage power input. For a given value of the Lagrange multiplier, an optimum power input, restricted by the maximum stage horsepower, is calculated for each section of the plant, again by an iterative scheme. The value of the Lagrange multiplier is adjusted until the desired total plant power is attained. An application of the model to a hypothetical gaseous diffusion plant is presented, which illustrates the gain that can be achieved from power optimization. (auth)

4780 (LMSC–680679) DESIGN STUDY OF INTEGRATED LIFE SUPPORT SYSTEM FOR AEROSPACE APPLICATION UTILIZING RADIOISOTOPES FOR THERMAL ENERGY. Final Report. Elms, R. V. Jr. (Lockheed Missiles and Space Co., Sunnyvale, Calif. Research and Development Div.). Mar. 31, 1968. Contract AT(04-3)-739. 209p. Dep. CFSTI.

The large amounts of thermal energy required to support crews for space missions beyond 180 days can be supplied by radioisotope thermal energy (RITE) sources. Life support system (LSS) components and techniques to identify an integrated acrospace life support system providing the highest reliable usable payload with the lowest possible launch weight are evaluated. RITE was also evaluated to determine the optimum energy source. The evaluations of life support system components, candidate isotopes and heating systems resulted in a conceptual design of an integrated life support system and the selection of an LSS component for detail design. The conceptual system design, utilizes an individual RITE source in the catalytic oxidizer and in the combined incinerator/urine vapor pyrolysis unit. A third RITE source heats a central heat transfer fluid loop (375°F) to supply energy to the remaining LSS components. A detailed design of the waste incinerator/urine vapor pyrolysis unit/RITE source was performed such that a functional-proof-of-principle component can be fabricated. Waste collection and incineration concepts were evaluated to select the design concept which involves the use of a man to handle collapsible waste collection cans and place them in the incenerator. The component design automatically controls the motion of an insulation slug, a cooling air blower, an oxygen supply valve and a space vent valve to perform a sterilization, pyrolysis, and incineration cycle. The nuclear radiation environment and shielding requirements associated with the ^{147}Pm RITE source were evaluated. A waste-management subsystem conceptual design, utilizing the incinerator/pyrolysis/RITE module, was also generated. (auth)

4781 (MLM-1564) ^{238}Pu ISOTOPIC FUEL FORM DATA SHEETS. Abrahamson, S. G.; Carfagno, D. G.; Kokenge, B. R. (comps.) (Mound Lab., Miamisburg, Ohio). Oct. 31, 1968. Contract AT(33-1)-Gen-53. 86p. Dep. CFSTI.

This report supersedes MLM-1441.

A compilation of data to Sept. 1, 1968, is presented for isotopic fuel forms of ^{238}Pu which have been studied and for which data have been accumulated at Mound Laboratory. Data were obtained from the open literature and unpublished Mound sources. Since some properties have not been determined for ^{238}Pu, analogous properties of ^{239}Pu are given whenever it could be assumed that these properties were not altered by the isotope or isotopic composition. Whenever ^{239}Pu data are given, this isotope is noted; otherwise data were obtained from ^{238}Pu. (auth)

4782 (NP-17673) PRIVATE OWNERSHIP AND OPERATION OF URANIUM ENRICHMENT FACILITIES. Report of a Forum Study Committee. (Atomic Industrial Forum, Inc., New York). June 1968. 81p. Atomic Industrial Forum, Inc., New York $10.00.

In late 1966 a study committee was assigned the task of determining the feasibility of transferring by sale or lease part or all of its gaseous diffusion plants from the AEC to private owner-operators, and if this is feasible and desirable, when and how it could be accomplished. The work of the committee is reported and its recommendations given in detail. The essential recommendations are that each of the three AEC uranium enrichment facilities be sold to separate competing companies at the earliest date at competitively bid prices, and that the new owner-operators accept AEC recommendations on the cost and availability of enrichment services to meet future commercial and government needs. (L.C.L.)

4783 (SC-RR-68-547) THERMAL AND ABLATION RESPONSE OF SMALL SPHERICAL PARTICLES IN REENTRY: SUMMARY REPORT. Marshall, B. W. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1968. 140p. Dep. CFSTI.

The reentry response of small spherical particles includes the thermal response of the particle and the melting of and mass loss (ablation) from the body. Results are presented of theoretical calculations to determine the conditions of melt for release in reentry, analytical studies to determine liquid layer and liquid droplet stability conditions in reentry, and experiments on small particle ablation conducted in a hyperthermal arc tunnel, a hypersonic shock tunnel, and a free-flight gun range. (auth)

4784 (SC-TM-68-627) THE AERIAL DETECTION OF ^{60}Co-FUELED RADIOISOTOPE THERMOELECTRIC GENERATORS. Everett, R. J. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1968. Contract AT(29-1)-789. 17p. Dep. CFSTI.

The aerial detection of a hypothetical ^{60}Co radioisotope thermoelectric generator is discussed for the ground level and earth and water penetration cases. A knowledge of ^{60}Co radiation fields and minimum detection levels of gamma counting equipment allowed an estimation of the detection altitude as a function of source size. Similar plots were constructed for the earth and water penetration case, using reported values for absorption and radiation buildup. Actual detection of ^{60}Co sources in the past allowed a comparison with theoretical predictions. (auth)

4785 STANDARDS OF ACTIVITY. Newbery, G. R. RCC Review No. 4. Amersham, Eng., Radiochemical Centre (UKAEA), 1968. 28p.

Most users of radioactive substances require to know the approximate activity of the material they are handling, if only to abide by safety regulations or so that they may purchase the minimum activity which will enable them to obtain required results. For such applications as the determination of the yield of nuclear reactions, and the measurement of cross sections, an accurate knowledge of activity is essential, and it is always desirable to use standards of known accuracy for the calibration of laboratory instruments. Standards of activity, statement of accuracy, types of standards available, certification of standards of activity, use of standards, and standards of activity available from the Radiochemical Centre are discussed. (UK)

4786 METHOD FOR ESTIMATING CRITICAL VELOCITY FOR DAMAGE TO RE-ENTERING FUELS IMPACTING END-ON. Silverstein, Calvin C. Nucl. Appl., 5: 437-44(Dec. 1968).

Equations are derived for the critical velocity at which damage is initiated during the end-on impact of solid and granular radioisotopic fuel rods with solid and granular earth materials. The equations show that high critical impact velocity, and hence high impact resistance, occurs for impacting materials with low density, small elastic modulus, high porosity, and high crush strength. An illustrative example is given in which the critical impact velocities are calculated for the impact of solid and granular quartz rods with dry sand, water-filled sand, and a rigid body. (auth)

4787 ISOTOPES AROUND THE WORLD. Isotop. Radiat. Technol., 6: 205-11(Winter 1968-69).

A brief review is given of isotopic source developments in several countries. Developments in the USSR include using spent fuel element sources for vulcanizing tires, using a cone-shaped γ source irradiation facility for irradiating similarly shaped plastic parts, and the construction of isotopic powered generators for unattended weather stations. Russian uses of radioisotopes in tracer techniques, and in monitoring and measuring systems are also outlined. Three abstracts are presented on uses of radioisotopes in Indonesia, on autoradiographic equipment and methods, and on the preparation of a ^{55}Fe source by electroplating. (L.C.L.)

4788 ISOTOPIC HEAT AND POWER DEVELOPMENT. Isotop. Radiat. Technol., 6: 188-99(Winter 1968-69).

The proceedings of the Colloquium on Isotopic Thermoelectric Generators, held in London, Jan. 30, 1968, are summarized. The seven papers cover general principles of radioisotopic thermoelectric generators, the RIPPLE series of generators, properties of thermoelectric materials, thermoelectric conversion theory, civil aviation applications, marine navigation applications, and other practical applications. (auth)

4789 SURFACE AREA MEASUREMENT IN CALCITE GRAINS BY ISOTOPIC EXCHANGE WITH ^{14}C-LABELED CARBON DIOXIDE. Anderson, Thomas F. (Columbia Univ., Palisades, N. Y.). Geochim. Cosmochim. Acta, 32: 1177-86(Nov. 1968).

In the method described tracer uptake is monitored by back-exchange of the surface activity into ^{14}C-free CO_2. ^{14}C activity is measured by direct liquid scintillation counting of 10 m-mole quantities of CO_2 dissolved in toluene under pressure. At 200° to 300°C reversible exchange of annealed calcite samples yields surface areas in good agreement with values determined by grain-size measurements. Exchange surface areas of unannealed grains are threefold higher than these "geometric" values. Although photomicrographs reveal that this excess "area" can be attributed in part to a rugged surface topography, internal surfaces, generated during the crushing of the sample, are also required. A measurable fraction of total exchange activity can only be recovered by dissolving the sample. This residual activity is probably the result of diffusion below the surface layer. The exchange reaction obeys a logarithmic rate law at 75° and 125°C. This suggests that the exchange mechanism involves the chemisorption of CO_2 on a calcite surface of heterogeneous reactivity. (auth)

4790 RADIOISOTOPIC PROPULSION. Bisiaux; Calabro (Societe pour l'Etude et la Realisation d'Engins Balistiques, S. A., Courbevoie, France). Air Cosmos, 5: 17-19(Feb. 3, 1968). (In French).

Description of the design and performance of an isotopic propulsion stage is presented. The principle of isotopic propulsion is the use of energy radiated by a radioelement to heat a fluid which is then released into a nozzle. The Poodle and Dart projects conducted in the U. S. to study different applications of isotopic propulsion are described. The use of isotopic propulsion in the case of long-range space explorations and in the transfer between a low orbit and a high orbit is discussed. Problems concerning the development and an isotopic stage are considered with particular attention to hydrogen conservation problems and problems related to the engine. (IAA)

4791 SEPARATION OF ARGON ISOTOPE MIXTURE IN AN AXISYMMETRIC SUPERSONIC JET. Mikami, Hisashi; Takashima, Yoichi (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo), 5: 572-8(Nov. 1968).

The diffusive separation of ^{36}Ar/^{40}Ar isotope mixture in an axisymmetric supersonic jet was analyzed numerically with account taken of the pressure diffusion in the jet. An approximate equation is proposed which gives the diffusion flux of the lighter component into the peripheral stream as a function of cut and Mach number. The experimental results presented by Becker, et al., are found to be in fairly good agreement with the results of calculation by the proposed equation. (auth)

Materials Testing

Refer also to abstracts 4794, 4797, 5072, and 5073.

4792 (UCRL-71267) ACOUSTIC EMISSION: STRESS WAVE DETECTION AS A TOOL FOR NONDESTRUCTIVE TESTING AND MATERIAL EVALUATION. Engle, Robert B.; Dunegan, Harold L. (California Univ., Livermore. Lawrence Radiation Lab.).

Sept. 13, 1968. Contract W-7405-eng-48. 28p. (CONF-680931-1). Dep. CFSTI.

From 8th Symposium on Physics and Nondestructive Testing, Schiller Park, Ill.

Methods for nondestructive test and material evaluation using acoustic-emission signals are reported. Experimental results show that emission from flawed specimens is characteristically different from emission from flaw-free specimens. Experiment also shows that acoustic emission from flawed specimens is normalized by the stress intensity factor that is basic to the study of brittle fracture. These results suggest applications to nondestructive testing and material evaluation that are being investigated. Work with some of these applications is described; notably a proposed acceptance test and fatigue crack extension monitoring, in the area of NDT; and determination of a critical stress intensity factor for stress corrosion cracking, in the area of material evaluation. Data from tensile tests of 7075-T6 aluminum suggest a correlation between the acoustic-emission rate and an expression describing mobile dislocation density as a function of plastic strain. Further search is intended for correlations between acoustic-emission behavior and dynamic dislocation parameters. Some of these planned efforts are described. A theoretical base is expected to lead to further applications and clearer interpretation of present NDT results. (auth)

Protective Structures

4793 (ORNL-TM-2362) PEAK OVERPRESSURE AT THE FOOT OF A VERTICAL WALL FACING AN AIR BLAST. Dresner, Lawrence (Oak Ridge National Lab., Tenn.). Sept. 19, 1968. Contract W-7405-eng-26. 18p. Dep. CFSTI.

Practical results for the pressure amplification in the right angle between two planes can be obtained by combining the known solutions of the problems of oblique and normal shock reflection. The results so obtained have been checked for various shock strengths and two angles of incidence by experiments carried out in an explosively driven shock tube. (auth)

Radioactive Material Handling

Refer also to abstracts 4755 and 4863.

4794 (AERE-R-5701) TYPE "A" PACKAGING FOR LIQUIDS AND GASES. Dixon, F. E.; Olley, F. K.; Cohen, L. R. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1968. 60p. Dep. CFSTI. UK 20s. 0d.

A proposal is made for amendment of the Additional Tests specified in I-3 Annex IV, and of design requirements in II-1.6 Annex II, I.A.E.A. Safety Series No. 6 (1967 edition). The median accident is given in Safety Series No. 7 as the basis for the amount of contents allowed in a "Type A" package. A Swedish experimental team in an interim report attempted to specify a median accident, and this led to the series of tests described. The conclusion appears to be that many Type A packages are capable of successfully withstanding the mechanical test prescribed in the regulations for Type B packaging and that if accidents more severe than the Type B tests are excluded there is no universal median accident. The series of tests suggests that the parameters in I-3 Annex IV and II-1.6 Annex II of the IAEA regulations are inappropriate in light of present experience, and an alternative approach to their respective requirements is suggested. (auth)

4795 (AERE-R-5871) A NEW STANDARD SERIES OF PACKAGINGS FOR LOAD UP TO 40,000 CURIES OF ^{60}Co OR EQUIVALENT. Dixon, F. E.; Cohen, L. R. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1968. 12p. Dep. CFSTI. UK 3s. 0d.

The packagings described consist in the main of packagings designed as a series rather than as an adaption of existing pots. New methods of thermal insulation and mechanical protection are included. The series does not include any special purpose pots, and is designed primarily to meet the needs of the commercial isotope transporter. (auth)

4796 (ORO-651(Rev.2)) URANIUM HEXAFLUORIDE: HANDLING PROCEDURES AND CONTAINER CRITERIA. (Oak Ridge Operations Office (AEC), Tenn.). Nov. 1968. 80p. Dep. CFSTI.

Routine handling procedures and container design and utilization criteria are presented for transactions involving the receipt or shipment of UF_6 by AEC. Topics covered are UF_6 weighing, sampling, cylinder emptying and filling, and cylinder inspection, cleaning, testing, and repair. Analytical and shipping procedures are discussed in general terms. Standard cylinder information, UF_6 properties, and safety considerations are presented as appendixes. (D.L.C.)

4797 INTRODUCTION TO RADIOACTIVITY FOR ENGINEERS. Coombe, R. A. New York, St. Martin's Press Inc., 1968. 173p. $6.50.

The phenomenon of radioactivity and its sources is presented and specific techniques and industrial uses are discussed. Characteristics of radioactive decay, radioisotope descriptions, physical properties of radiation, techniques and equipment for radiation measurements, radioisotope technology, industrial and scientific uses of radioisotopes, and safety procedures with radioactive materials are discussed. (J.C.W.)

4798 THERMAL BEHAVIOR OF SHIPPING CASKS UNDER FIRE CONDITIONS. Wachtell, G. P. (Franklin Inst. Research Labs., Philadelphia); Langhaar, J. W. Contract AT(07-2)-1. Nucl. Eng. Design, 8: 273-88(1968).

To provide basic information for more reliable prediction of temperatures in a shipping cask under external fire conditions, a 15-ton lead-shielded cask was subjected to a large, open-air petroleum fire for 1 hr. Experimental results were correlated by electrical analog computation, using various assumed values for important parameters. The radiant absorptivity (α) of the cask was found both by analog computations and by hand calculations to be about 0.6. Although the cask was externally finned, α was calculated from the area of the outer shell excluding the fins, which contribute little to radiant heat transfer. Convection of molten lead in the walls was found to be such that the horizontal temperature gradient in the molten lead was negligible. On the other hand, the maximum vertical temperature gradient was about 8°F per inch of height. Hand-calculation methods are presented for predicting the extent of melting as a function of time for lead-shielded casks of rectangular or cylindrical shape, for any selected fire conditions. Methods are also suggested for estimating the maximum cavity temperature in casks with either lead or non-melting shielding. (auth)

Vacuum Engineering

Refer also to abstract 5725.

4799 PHYSICAL PRINCIPLES OF ULTRA-HIGH VACUUM SYSTEMS AND EQUIPMENT. Robinson, Norman W. New York, Barnes and Noble, Inc., 1968. 276p. 75s; $12.00.

The physical principles of ultra-high vacuum systems and equipment include mechanical appliance technology, measurement of pressure, mass spectrometry applications, principles of leak detection, and pumping by ionization, sorption, and cryogenics. Residual gases in a system depend on gas-surface conditions. Adsorption and transfer of gases are discussed. Degassing phenomena and the preparation of cleaning surfaces are summarized. (J.C.W.)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 4559 and 4797.

General Detectors and Monitors

Refer also to abstracts 4838 and 4839.

4800 (ANL-Trans-631) ON THE APPLICATION OF SEMICONDUCTOR DETECTORS IN X-RAY FLUORESCENCE ANALYSIS. Pshiborski, V.; Khvashchevska, Ya.; Charnatski, V.; Shimchak, M. (Institute of Nuclear Research, Warsaw (Poland)). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report INR-820/11/PS. 10p. Dep. CFSTI.

This paper was previously abstracted from the original language and appears in NSA as 22: 19096. (W.H.K.)

4801 (ANL-Trans-642) FILM-TYPE SCINTILLATION DETECTOR FOR MEASUREMENT OF THE TOTAL NUMBER OF CAPTURES IN THE RESONANCES OF THE (n,γ) REACTION. Danelyan, L. S. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report IAE-1349. 7p. Dep. CFSTI.

This paper was previously abstracted from the original language and appears in NSA as 22: 19095. (W.H.K.)

4802 (ANL-Trans-688) WHOLE BODY MEASUREMENT WITH NaI-CRYSTALS. SENSITIVITY AND ACCURACY OF THE MEASUREMENT WITH DIFFERENT DETECTOR ARRANGEMENTS. Schneider, Claus; Linden, Walfried A. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Strahlentherapie, 133: 213-32(1967). 28p. Dep. CFSTI.

Using a whole body counter with 4 NaI-crystal detectors, the sensitivity and accuracy of the 4 mostly used methods for whole body counting are compared: single crystal device with tilting chair, line arrangement of the detectors, simple scan measurements with 2 and 4 detectors. The highest sensitivity for the detection of γ-sources was obtained with the tilting chair device; it was reduced for about 20% in the line arrangement and for about 50% in the scan measurements. Sources distributed irregularly in the body were measured, with greater accuracy, with four detectors in line (using the optimum conditions as obtained with a computer program) than by the use of the tilting chair device and the simple scan measurements. In the case of radioprotective investigations, preference should be given to the linear device; scan measurements are not suitable at all. In the case of clinical problems the line device as well as the modified scan measurements are recommended; the tilting chair device is not suitable. (auth)

4803 (BNWL-SA-2108) IONIZING RADIATION: SURVEY AND CONTROL TECHNIQUES. Howell, W. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 19, 1968. 8p. (CONF-680930-3). Dep. CFSTI.

From Electromagnetic Spectrum Conference, Richland, Wash.

Control of exposure to ionizing radiation is discussed. Limitation of exposure time, use of maximum practicable distance between the radiation source and the exposed individual, and the use of shielding are fundamental considerations. Radiation instruments, survey techniques, and errors in measurement are discussed. (W.H.K.)

4804 (IN-1211) ICPP FISSIONABLE ISOTOPE MONITOR: STATUS REPORT. Booman, G. L.; Morgan, J. P.; Maeck, W. J.; Beard, H. R.; Lisman, F. L.; Rein, J. E. (Idaho Nuclear Corp., Idaho Falls). Oct. 1968. Contract AT(10-1)-1230. 51p. Dep. CFSTI.

Design and construction of a prototype instrument for continuous monitoring of fissionable isotope concentrations in processing plant streams is described. Measurements are based on the delayed neutron technique with irradiation of the plant stream by a ^{238}Pu-Be neutron source and detection of delayed neutrons with $^{10}BF_3$ filled tubes. A small, general-purpose computer transforms the pulse signals from the $^{10}BF_3$ tubes to fissionable material level through calculations involving input data reflecting sample stream flow rate in the monitor, attenuation of neutron flux by boron or other neutron absorbing material in the stream, and calibration factors. This on-line computer also provides continuously updated trend prediction, total amounts of fissionable isotopes in the receiving tanks, and is programmed to actuate alarms upon recognition of fissionable material levels which could build up to levels causing a nuclear unsafe condition, and to give warnings of abnormal conditions resulting from plant equipment deterioration, equipment failure, operator error, or intentional attempts to divert fissionable material. Sensitivity of the prototype instrument is better than 0.001 g/l of ^{235}U. Suggestions are made for an operational model of the fissionable material monitor system for installation in the Idaho Chemical Processing Plant on low level waste, plant input, or intermediate streams. (auth)

4805 (JPRS-46925) PATROL INSTRUMENT FOR REGISTRATION OF PRIMARY COSMIC RADIATION. Shafer, Yu. G.; Yargin, A. V. Translated from Geomagn. Aeron., [8:] No. 4, 765-9(July-Aug. 1968). 10p. CFSTI.

Apparatus is described for use on artificial satellites as a patrol instrument for registration of cosmic radiation in the energy interval susceptible to the influence of the earth's magnetic field. (auth)

4806 (LA-DC-9626) A MULTIPLIER FOR USE WITH E-dE/dX PARTICLE IDENTIFIERS. Aiello, W. P.; Singer, S. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 10p. (CONF-681017-7). Dep. CFSTI.

From 15th Nuclear Science Symposium, Montreal, Canada.

The Vela 5 satellite energetic particle experiment will employ an E-dE/dX particle identifier in which the 2-pulse multiplication is performed by a gated, constant current circuit. The multiplication time is proportional to pulse height and varies between 1.5 and 15 microseconds. The multiplier output is a reasonably accurate representation of the product of the input pulses, and is nearly independent of temperature. (auth)

4807 (NP-17693) LIQUID SCINTILLATION COUNTING. Third Edition. (Nuclear-Chicago Corp., Des Plaines, Ill.). July 1968. 34p.

The theory of liquid scintillation counting, statistics and resolution, and sample preparation are discussed. Also, a bibliography on liquid scintillation counting is presented. (W.H.K.)

4808 (NSJ-tr-128) RELATIVE RESPONSES OF ORGANIC COMPOUNDS IN RADIOACTIVE IONIZATION DETECTOR. Takeuchi, Tsugio; Kobayashi, Kousuke. Translated from Kogyo Kagaku Zasshi, 70: 33-6(1967). 13p. Dep.

Relative responses of many organic compounds were measured by a radioactive ionization detector, where the influences of molecular weight and carbon number on the responses were also examined. The same relative molar response was obtained with a series of closely related compounds, such as n-aliphatic hydrocarbons, 2-methyl substituted aliphatic hydrocarbons, aromatic hydrocarbons and alcohols, even if their molecular weights are different from each other. Moreover, this trend was supported by a theoretical curve based on the assumption that the Penning effect mainly occurred in the ionization chamber in comparison with other factors, such as ionization potential, the ionization cross-section area, the probability of recombination and the velocity of the collision between the test molecules and the metastable argon atoms. The relative molar responses, however, are different toward detectors. This comes from the differences in the radioactive source and the internal applied potential of each detector. Using the relative responses obtained, the determination of the components of the mixture in the same series was easily made within the range of experimental error. Also, the changes of the response itself and relative response, when the applied potential and the flow rate of carrier gas were changed, were examined and discussed. (auth)

4809 NUCLEAR PARTICLE DETECTOR OF THE GAS TYPE. Lansiart, A.; Lequais, J.; Leloup, J. (to Commissariat a l'Energie Atomique). Canadian Patent 789,665. July 9, 1968. Priority date Apr. 17, 1964, France.

A detector is described for the identification of β, γ, and x-radiation. It consists of an accelerating chamber defined between a cathode and a grid oriented in parallel, a spark chamber between the grid and an anode also oriented in parallel with the grid, a gas enclosure containing an argon-methane mixture at atmospheric pressure surrounding the anode, grid, and cathode. The electrical potential between the anode and the grid has a value slightly less than the breakdown voltage of the spark chamber. A different potential is imposed between the cathode and grid for accelerating electrons toward the grid whereby radiation on the cathode will ultimately cause a spark discharge. The grid has a lattice pitch of about 75 microns. Other details of construction are also indicated. (Canada)

4810 DEAD-TIME CORRECTION FOR MIXTURES OF SHORT-LIVED RADIONUCLIDES. Rossitto, F.; Terrani, M. (CESNEF, Milan). Int. J. Appl. Radiat. Isotop., 19: 871-5(Dec. 1968).

The general form for the dead-time correction in the case of a mixture containing any number of radionuclides, and when the counting time is long compared with the half-lives of the components of the mixture, is presented and discussed. (auth)

4811 DIRECT MEASUREMENT OF $^{14}CO_2$ IN A LIQUID SCINTILLATION COUNTER. Horrocks, D. L. (Argonne National Lab., Ill.). Int. J. Appl. Radiat. Isotop., 19: 859-64(Dec. 1968).

Samples of CO_2 were dissolved in a liquid scintillator solution for the measurement of ^{14}C activity with counting efficiencies greater than 90% above an appropriate low-energy bias. With an integral counting technique a counting efficiency of (100 ± 2)% was obtained. As much as 5 ml (STP) of CO_2 per ml of scintillator solution produced no measurable quenching. (auth)

4812 RAPID METHOD OF ^{14}C COUNTING IN ATMOSPHERIC CARBON DIOXIDE. Povinec, P.; Saro, S.; Chudy, M.; Seliga, M. (Comenius Univ., Bratislava). Int. J. Appl. Radiat. Isotop., 19: 877-81(Dec. 1968).

A simple method of collecting samples and an apparatus for the preparation and activity measurement of samples of atmospheric carbon dioxide is described. Using this technique, the time for the purification of carbon dioxide for carbon-14 activity measurement was about 6 hr. The carbon-14 activities observed in the atmosphere around the nuclear power-station at Trnava during autumn 1967 (before its starting) are reported. (auth)

4813 TRACK DENSITY MEASUREMENT IN DIELECTRIC TRACK DETECTORS WITH SCATTERED LIGHT. Schultz, Warner W. (Knolls Atomic Power Lab., Schenectady, N. Y.). Contract W-31-109-eng-52. Rev. Sci. Instrum., 39: 1893-6 (Dec. 1968). (KAPL-P-3369).

Fission track densities in glass and in Lexan polycarbonate resin have been measured using light scattered from the tracks as a measure of the track density. Scattered light was found to be proportional to track density up to the point at which tracks begin to overlap. For the two track detector materials tested, a scattering angle was found at which optimum signal-to-background ratios are obtained. (auth)

4814 ANGULAR CORRELATION AND DISTRIBUTION ATTENUATION COEFFICIENTS FOR PLANAR AND COAXIAL Ge(Li) DETECTORS. Avignone III, F. T.; Frey, G. D. (Univ. of South Carolina, Columbia). Rev. Sci. Instrum., 39: 1941-3 (Dec. 1968).

The coefficients Q_2 and Q_4 used to correct experimentally determined A_2 and A_4 angular correlation and distribution coefficients, for the finite solid angle subtended by the detectors, are tabulated for various planar and coaxial Ge(Li) detectors. The following planar detectors are considered: (1.1 cm radius × 0.4 cm thick), (1.1 × 0.6), (1.4 × 0.5), (1.4 × 1), (1.6 × 0.6), (1.6 × 0.9), (1.8 × 0.8), and (2 × 1). The coaxial detectors considered are (1.3 cm radius × 3.5 cm long), (1.3 × 4), (1.3 × 4.5), and (1.3 × 5), each with a 0.6 cm bore on the axis. These represent popular, commercially available detector sizes. Tabulations of the coefficient for the case in which all absorption occurs on the surface, and for the case in which it occurs on a midplane, are included. The latter may be used for corrections when charged particle detectors are used. (auth)

4815 STUDY OF THE RADIATION DETECTOR. Takahashi, Teiko (Shibaura Inst. of Tech., Japan). Shibaur Kogyo Daigaku Kenkyu Hokoku, No. 15, 223-5(1967). (In Japanese).

A method is described for preparing a p-n junction semi-conductor of surface-barrier type for radiation detection. The method used is evaporating gold in vacuum and depositing it onto an n-type silicon disc. A rectifying contact is made which, under reverse bias, becomes a detector for ionized particles. (NSA of Japan)

4816 PHOTOMETRIC PROPERTIES OF PHOTOGRAPHIC LAYERS IRRADIATED BY A DIRECTED CHARGED PARTICLE FLUX. Matvienko, V. I.; Petrzhak, K. A.; Tregubova, T. M. Zh. Nauch. Prikl. Fotogr. Kinemotogr., 13: 351-3(Sept.-Oct. 1968). (In Russian).

The effects of the angle of incidence on the photometric properties of nuclear emulsions irradiated by alpha particles were investigated. (R.V.J.)

4817 PROPERTIES OF SILVER BROMIDE EMULSIONS IRRADIATED BY RADIOWAVES. Zinov'ev, O. A. Zh. Nauch. Prikl. Fotogr. Kinemotogr., 13: 353-4(Sept.-Oct. 1968). (In Russian).

Data obtained on the effects of electromagnetic radiation in the millimeter range on the regression processes in latent images showed that under superhigh frequency irradiation silver bromide photoemulsions alter their radiosensitivity. It was assumed that the sensitivity of photographic material to the radioemission is related to the changes in dark conduction induced by superhigh frequency heating in silver bromide emulsions. (R.V.J.)

4818 COUNTER TELESCOPES. Somorjai, E. ATOMKI (At. Kut. Intez.) Kozlem., 10: 170-83(1968). (In Hungarian).

It is not possible to examine nuclear reactions induced by fast neutrons with the same degree of accuracy as the charge-particle-induced reactions in low-energy physics. It is important to determine the background as precisely as possible. The neutrons are emitted in every direction, and they induce nuclear reactions not only in the target but also in the detector and the ancillary equipment; therefore the target and the detector must be separated from each other and the background must be kept low. This may be achieved electronically by using several detectors, correlated by coincidence or anticoincidence circuits. These systems which are well suited to detect particles emitted in specific directions, are designated as telescopes. The thin-target telescopes include various detectors, such as proportional counters, thin scintillation crystals, thin semiconductor detectors, and gas scintillation counters. The characteristic parameters of each type and point of specific interest for the design of the various types of instruments are listed. (Summarizing review article, 16 references.) (TTT)

4819 IONIZING PARTICLE EFFECTS ON PHOTOGRAPHIC SOLARIZATION. Kartuzhanskii, A. L.; Khapachev, A. G. Zh. Nauch. Prikl. Fotogr. Kinemotogr., 13: 348-50(Sept.-Oct. 1968). (In Russian).

Studies of photographic layer darkening as a function of α-particle dose (plutonium-239 source) showed that with the dosage increment the density increase was replaced first by solarization and then by secondary inversion similar to the case of light. The solarization during α-particle exposition can be accelerated by additional illumination. Moreover, the effects do not depend on the spectral composition of the illumination. (R.V.J.)

4820 USE OF SEMICONDUCTOR COUNTERS FOR THE DETECTION OF NEUTRONS ACCOMPANIED BY γ RAYS. Kireev, P. S.; Kalugina, L. I.; Stepanyan, A. I.; Samosadnyi, V. T.; Mitin, V. I.; Vinogradov, V. M. At. Energ. (USSR), 25: 239-40(Sept. 1968). (In Russian).

Effects of γ background on the properties of neutron detectors using ^6Li and ^{235}U radiators were studied using silicon surface-barrier detectors with resistivity $\rho = 200$ ohm · cm; a resolving power, calculated with ^{239}Pu α-particles, of 0.9 to 1.2%; and working surface of 16 mm^2. The pulse-height distribution for the $^6Li(n,\alpha)^3H$ reaction in a γ background of 0.01 to 0.02 R/sec, and the spectra of fission fragments from ^{235}U irradiated by thermal neutrons of the IRT-M reactor in a γ background of 0.01 to 10 R/sec were analyzed. Data obtained showed that it was impossible to detect neutrons with radiators producing light charged particles when under conditions of weak γ background. However, with radiators which induce fission even significant γ background does not inhibit detector operations. (R.V.J.)

4821 PULSE IONIZATION DETECTOR IN SELF-COINCIDENCE CONNECTION. Sedin, G. Z.; Trukhanov, K. A. At. Energ. (USSR), 25: 63-4(July 1968). (In Russian).

In order to improve the resistance of pulse ionization signal recorders against interferences, the self-coincidence system was investigated. It is based on the simultaneous recording of pulses from several electrodes, equalizing them by means of a time-amplitude scheme which records the signals only if the pulse delay corresponds to a preset time period and the amplitudes follow a given predetermined correlation. The results indicated that the self-coincidence method makes it possible to reduce the background level. An experimental check of the theoretical derivations confirmed the findings. The proposed method is more effective than those currently used to suppress interferences. It may be employed for detectors, the operation of which is based on the motion of the charge carriers in the electrode gap, such as semiconductor detectors, proportional counters, etc. (TTT)

4822 RADIATION ENERGY MEASURING DEVICE. Habert, P. (to Quartz and Silice). Canadian Patent 792,867. Aug. 20, 1968. Priority date Apr. 16, 1964, France.

A scintillation device is described which uses a radioactive reference source of half life in excess of one year ^{239}Pu, ^{241}Am, ^{243}Am, ^{208}Po or ^{209}Po joined to the face of a pure crystal of sufficient thickness to block the α radiation. The other face of the crystal is optically coupled to the primary scintillator. With such an arrangement, the energy from the radioactive reference source is far above that of the range of radiation energy to be measured. It is then possible to use the known energy from the source as a standard of calibration of the scintillator. Incident radiation generates light in the primary scintillator which is then converted into electrical energy by photomultiplying apparatus. Thallium-activated NaI is a suitable material for the crystal. (F.S.A.)

4823 CONTINUOUS MONITORING OF COLUMN-CHROMATOGRAPHIC ACTINIDE AND FISSION PRODUCTS SEPARATIONS. Weinlaender, W.; Hoehlein, G. (Technische Hochschule, Munich). Kerntechnik, 10: 563-7(Oct. 1968). (In German and English).

The principle and construction of a measuring apparatus for the continuous determination of gamma and alpha activities in the course of actinides and fission products separations are described. Provisional identification of the nuclides being separated is possible by means of gamma spectra measured by a second detector. The efficiency of the arrangement is illustrated on two separation examples, and the possibilities of evaluation of the results obtained are discussed. (auth)

4824 FREQUENCY OF SPURIOUS ALARMS IN CONTINUOUS RADIATION MONITORING WITH A MEAN VALUE COUNTER. Andresen, E. G.; Gehrmann, W. (Laboratorium fuer Kernstrahlungs-Messtechnik, Berlin). Kerntechnik, 10: 555-62(Oct. 1968). (In German and English).

From the operational data of a monitoring facility it is possible to calculate the frequency of spurious alarms and the detection limit. The mean time interval between spurious alarms can easily be raised to one year or more, but substantially shorter alarm intervals continue to occur. The majority of spurious alarms is shorter than the mean pulse interval 1/n of the threshold pulse rate n, and can easily be suppressed. The suppression of spurious alarms can be used for a continuous monitoring of the functional competence of the monitoring facility. (auth)

4825 ON THE DETECTION OF NEUTRONS WITH THE ETCH-PIT COUNTING METHOD. Nishiwaki, Y.; Tsuruta, T. (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, 17: 131-42(Nov. 1968).

Fission fragments mark scars on such an insulator as glass or mica, when neutron induced fission of the fissionable material takes place on the surface of or inside the insulator material. Very small scars on the surface of the insulator material caused by the fission fragments can be etched by the suitable chemical treatment to form etch-pits visible under the ordinary microscope. Therefore the combination of the fissionable material and the insulator material can be used for neutron detection or neutron dosimetry. A thin film of uranium or thorium was electrodeposited on gold foil as the fissionable material and the glass or mica was used as the detector material of the fission fragments. The thin film of the fissionable material was kept in contact with the surface of the glass or mica. The effect of the different etching condition and the stability of the stars have been studied. It has been shown by the fission film-glass or mica combination that a good agreement exists between the expected number of fissions and the number of etch-pits. Because of the use of the thin film of the fissionable material much thinner than the average range of the fission fragments, the effects of the spontaneous fissions may be considered negligible and the upper limit of the neutron measurement may be greatly increased. A wide range of neutron exposure 10 mrem to 1000 rem may be measured with a single detector of this type with reasonable accuracy. The activation of the metal, on which the fissionable material is electrodeposited, permits another simultaneous measurement of neutron flux at the time of accidental exposure, independently of the stored information of the neutron exposure recorded on the insulator material. Distribution of thermal neutron flux in the reactor (UTR-B) was estimated with this system. The results of the etch-pit counting were in good agreement with those estimated with the activation method. (NSA of Japan)

4826 ^{14}C IN ATMOSPHERIC CARBON DIOXIDE. Chudy, Martin; Saro, Stefan; Seliga, Mojmir; Povinec, Pavel (Komenskeho Univ., Bratislava). Fyz. Cas., 18: 162-8(1968). (In Czech).

A description of the instrumentation used for measurements of the radiocarbon concentration in the atmosphere during tests carried out in the Radioactivity Data Processing Laboratory, Comenius University (Bratislava, Czechoslovakia) is presented. An apparatus was constructed consisting of a device for obtaining carbon dioxide from the air near the earth surface, a device for purification of carbon dioxide, and a device consisting of counters with electronics. The activity of atmospheric carbon dioxide was determined by measurements in the internal proportional counter. A schematic of the carbon dioxide purification system is presented, and its operational process is described. A block diagram of the counting system is also given. (IAA)

4827 CALCULATED EFFICIENCIES OF CYLINDRICAL Ge(Li) DETECTORS. Iyengar, K. V. K.; Lal, B. (Tata Inst. of Fundamental Research, Bombay). Indian J. Phys., 42: 85-90 (Feb. 1968).

Detection efficiencies of Ge(Li) detectors of cylindrical geometry for point sources placed on the axis of the detector were calculated for gamma ray energies ranging from 0.01 to 10.00 MeV on a CDC 3600 computer. Detectors of area of cross-section 2 to 10 sq. cm. and of various depletion depths were considered for source to crystal distances ranging from 1 to 25 cm. (auth)

4828 A PORTABLE BETA-GAMMA FOOT MONITOR. Neely, Glenn W. (Los Alamos Scientific Lab., N. Mex.). Health Phys., 16: 98(Jan. 1969).

In order to control contamination within a laboratory room or corridor there was a need for an economical, portable and reliable foot monitor, which could be used with existing survey instruments. A foot monitor to meet these requirements, developed at the Los Alamos Scientific Laboratory, is described. (auth)

4829 MOUSE RESTRAINER FOR SCINTILLATION COUNTING. Stoddart, R. C. (Univ. of Glasgow). Lab. Pract., 17: 1358(Dec. 1968).

The apparatus described was designed so that wild mice could be restrained with the minimum of disturbance while whole-body counts of radioactivity were made during a study of thyroid function. (auth) (UK)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 4588 and 5945.

4830 METHOD FOR MEASURING THE CONCENTRATIONS OF THE SHORT-LIVED DAUGHTER PRODUCTS OF ^{222}Rn IN THE ATMOSPHERE. Duggan, M. J.; Howell, D. M. (Radiological Protection Service, Sutton, Eng.). Int. J. Appl. Radiat. Isotop., 19: 865-79(Dec. 1968).

A method is described for the simultaneous determination of each of the short-lived daughters of ^{222}Rn. The method entails sampling the atmosphere of interest through a filter and carrying out α-spectrometry on the activity collected on the filter. The spectrometry measurements must be made both during and after sampling. From a knowledge of the RaA and RaC disintegrations occurring on the filter it is possible to calculate the atmospheric concentrations of RaA, RaB, and RaC. The determinations made by the method indicate that its accuracy is sufficient to obtain meaningful results with the smallest daughter product concentrations found in the atmosphere. (auth)

4831 CALIBRATION OF A SATELLITE-BORNE SOFT PARTICLE SPECTROMETER. Wright, W. H. (Southwest Center for Advanced Studies, Dallas). Rev. Sci. Instrum., 39: 1909-16(Dec. 1968).

The calibration of an electrostatic deflection, auroral particle spectrometer, which uses bare electron multipliers for detectors, is described. The spectrometer measures the fluxes of both electrons and protons in the energy range 10 to 10,000 eV. An attempt is made to minimize the uncertainty in the measurement of the absolute particle flux to which such instruments are prone. The detection of electrons and protons by electron multipliers is investigated as a function of energy and flux of the particles, and for different values of the multiplier gain. (auth)

4832 AN INSTRUMENT FOR THE STUDY OF MOMENTS OF EXCITED NUCLEAR STATES BY ANGULAR CORRELATION METHODS. PART C: TRANSISTORIZED ELECTRONIC EQUIPMENT. Johansson, K.; Karlson, A.; Kozyczkowski, J. (Inst. of Physics, Uppsala). Ark. Fys., 37: 251-60(1968).

In preceding papers, accurate methods for measuring small perturbations in gamma-ray angular correlations were presented. Here, a transistorized electronic system extended from 4 to 8 coincidence combinations is presented. The measuring time is thereby reduced by 75% and the apparatus is now more stable than before. (auth) (Sweden)

4833 ON THE SIMULTANEOUS MEASUREMENTS OF THE PARTICLE SIZE DISTRIBUTION OF RADIOACTIVE CHARGED AEROSOLS AND CONCENTRATION RATIO OF POSITIVE TO NEGATIVE. Sekikawa, Toshio; Mochizuki, Sadamu (Tokyo Univ.). J. Radiat. Res., 9: 73-83(June 1968).

For measuring the mobility spectrum of radioactive charged aerosols, a newly designed parallel plate type spectrometer was constructed in 1966-1967, on the basis of the Erikson's spectrometer. By this spectrometer, positive and negative mobility spectra, and the concentrations of both the signs in each fine range of mobility are obtained simultaneously from the same sampled aerosol particles. In this paper, theory of measurements of mobility spectra, examinations of air flow pattern in the chamber and tests for some radioactive aerosols stored in a vessel are described. (auth)

High Energy Physics Instrumentation

Refer also to abstract 5793.

4834 (DESY-68/43) THERMODYNAMICS OF BUBBLE CHAMBER EXPANSIONS. Horlitz, G.; Wolff, S.; Harigel, G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sept. 1968. 51p. Dep.

On the basis of an adiabatic theory a number of equations is given, which allow the study of the relations between expansion ratio, dynamic pressure, and the parasitic boiling in a bubble chamber. A dirt function η is defined as the molar fraction of the liquid which is evaporated during an expansion cycle. Furthermore a method is presented to measure η under certain assumptions from pressure-volume-diagrams of bubble chamber expansions. A number of p-v-diagrams taken in the 85 cm bubble chamber at DESY, has been studied; first results could be qualitatively compared with theory. The adiabatic compressibility of liquid hydrogen and deuterium has been measured at different temperatures. (auth)

4835 (DESY-68/45) MEASUREMENTS OF BUBBLE DENSITIES IN LIQUID HYDROGEN AND LIQUID DEUTERIUM. Horlitz, G.; Wolff, S.; Harigel, G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Aug. 1968. 14p. Dep.

Bubble densities have been measured on tracks of electrons of about 2 GeV/c in an 85 cm bubble chamber at DESY. The chamber was either filled with liquid hydrogen or with liquid deuterium. The measuring procedure including the measurement of all parameters as well as the evaluation of the data is described. Measurements have been made in large temperature and pressure intervals. Points of equal bubble density in a p-T-diagram have been fitted to parabolas through the critical point. (auth)

4836 IZLUCHENIE VAVILOVA–CHERENKOVA I EGO PRIMENENIE V FIZIKE VYSOKIKH ENERGII. (Vavilov–Cherenkov Radiation and Its Uses in High-Energy Physics). Zrelov, V. P. Moscow, Atomizdat, 1968. 276p.

A comprehensive review is given on the Vavilov–Cherenkov radiation its properties and applications. The first chapter includes various aspects classical Tamm–Frank theory of Vavilov–Cherenkov in isotropic and anisotropic media and correlations of the available theoretical and experimental data. The second chapter covers various practical applications of V–C radiation in nuclear physics. Characteristics and performance of various types of Cherenkov counters (particle beam detectors, energy monitors, and single-particle counter) are described and their applications analyzed. (R.V.J.)

Radiation Dosimeters

4837 (BNWL-SA-1765) DOSIMETRY OF ALPHA EMITTERS IN THE LUNG. Andersen, B. V.; Bramson, P. E.; Larson, H. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 17, 1968. Contract AT(45-1)-1830. 22p. (CONF-681013-1). Dep. CFSTI.

From Symposium on Dosimetry of Low Energy or Short Range Irradiations, Menton, France.

Experience in the operation of several prototype systems for the detection of uranium and plutonium isotopes and ^{241}Am in the lung is discussed. For natural and enriched uranium, a lung counter with a 9-inch diameter by 4-inch thick sodium iodide crystal provides a detection level equivalent to about 20% of a lung burden. Several lung counting systems are available for measuring the x and gamma rays from plutonium and americium. If ^{241}Am is present, four 12 cm diameter by 1 centimeter thick sodium iodide crystals mounted on low-noise photomultipliers and located on both the front and the back of the chest are utilized. Such a system will detect about 0.1 nCi of ^{241}Am which can be related to the deposition of plutonium in the lung when the ratio of ^{239}Pu to ^{241}Am is known. Reasonable values for this ratio may range from 5 to 20; thus indicating a lung deposition of from 0.5 to 2 nCi of ^{239}Pu. Thin sodium iodide crystal (1 mm thick) arrays and proportional counters are also available for detecting the 17 keV x-rays from plutonium isotopes. The detection level of these counters is about 10 nCi. A projection chest phantom was designed and constructed that is especially useful for calibration of in vivo lung counters when measuring low energy x-ray and gamma rays (10–100 keV). This inexpensive phantom provides complete variability of chest thickness and incorporates bone structures of a bone equivalent material. (auth)

4838 (NSJ-tr-137) ENERGY ABSORPTION SPECTRUM-RADIATION DOSE OPERATOR. PRINCIPLE AND THE AUTOMATION OF OPERATION. Miyanaga, Ichiro; Moriuchi, Shigeru. Translated from Nippon Genshiryoku Gakkaishi, 9: 440-6; 518-23(1967). 24p. Dep.

Hurst and Ritchie have presented a generalized concept for radiation dosimetry, which relates the response of detectors to the dose received by other systems of interest. This formulation can explain as a whole the principles of many kinds of detectors and methods used in radiation dosimetry, and is characterized by the introduction of the operator acting upon the energy absorption distribution function in a detector. A new method of determining the generalized operator is presented, which permits the treatment of any type of radiation dose with any detector system, and its characteristics are discussed. Shown as examples are the generalized operator in an NaI(Tl) scintillation detector for the determination of gamma exposure (R), and the same in a liquid scintillation detector for neutron dose equivalent (Rem) measurement. The generalized operator discussed is a kind of weighting function to govern the energy absorption distribution function. In this respect, the methods based on time encoding and binary scaling are expedient for automatic weighting of energy. Both these methods however entail complex electronic circuits except in cases where the operator has the form of a linear function. For automatic operation of the generalized operator, it is shown that automatic discrimination bias modulation possesses the flexibility required for adaption to any form of operator. This method uses ac waves for the discrimination bias, which takes the form of inversed operator-function, so that passage through gate of the input signal from the detector can be determined by its pulse height, and thus permits obtaining an output proportional to the radiation dose of interest. Electronic circuits are shown for possible forms of the operator function. (auth)

4839 (ORNL-TM-2334) RADIATION SURVEY AND DOSIMETER INTERCOMPARISON STUDY AT THE HEALTH PHYSICS RESEARCH REACTOR. Kerr, G. D.; Johnson, D. R. (Oak Ridge National Lab., Tenn.). Nov. 1968. Contract W-7405-eng-26. 19p. Dep. CFSTI.

A combined radiation survey and dosimeter intercomparison has been completed at the DOSAR Facility within the general environs of the Health Physics Research Reactor (HPRR). Detectors used in the survey were a Phil miniature G-M counter, a Hurst proportional counter, and a BF_3 proportional counter for measurements of gamma-ray absorbed-dose rates in a small tissue sample, fast-neutron absorbed-dose rates in a small tissue sample, and thermal neutron flux, respectively. Since an instrument for measuring dose from intermediate energy neutrons (0.5 eV to 100 keV) as a separate component is not available, a Rossi tissue-equivalent ionization chamber and a Bonner detector which both respond over the entire neutron energy spectrum were intercompared with the above detectors. Response of the Rossi ion chamber is proportional to absorbed dose in a small mass of tissue, and that of the Bonner detector is proportional to maximum dose equivalent in a man-size torso irradiated by parallel beams of neutrons. Intercomparisons were made using conversion factors between the different dose concepts presented in NBS Handbook 63. (auth)

4840 (RD/B/N-830) MEASUREMENT OF BETA DOSES IN OPERATIONAL HEALTH PHYSICS WITH THERMOLUMINESCENT LITHIUM FLUORIDE. Harvey, J. R.; Townsend, S. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Sept. 1967. 18p.

Thermoluminescent LiF is being increasingly used in radiation environments in the C.E.G.B. for the measurement of skin dose. In situations where skin dose is the dominant hazard a significant part of the dose is often due to beta radiation. Investigations into the response to beta radiation of the LiF skin dosimeter which is used predominantly in the C.E.G.B. are described. (auth)

4841 (SC-T-68-1549) POSSIBILITIES OF THE USE OF PHOTORESISTORS MADE FROM SINTERED CADMIUM SULPHIDE AS DOSIMETERS FOR X-RAY RADIATION. Kynev, S.; Stoyanov, V.; Shekerdzhiiski, V. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Compt. Rend. Acad. Bulg. Sci., 17: 447-9(1964). 4p. Dep. CFSTI.

Results of preliminary tests on the use of the photoresistance properties of sintered cadmium sulfide for x-ray dosimetry are presented. (W.H.K.)

4842 TRACK FADING IN NEUTRON PERSONAL MONITORING FILM UNDER TYPICAL USE CONDITIONS. Zelac, R. E. (Illinois Inst. of Tech., Chicago). Health Phys., 15: 545-8(Dec. 1968).

Recoil proton track fading in neutron personal monitoring film has been investigated previously under a variety of temperature and humidity conditions. Usually the investigations were under-

taken to determine suitable use periods for neutron badges at particular installations. Since most neutron work at the IIT Research Institute is done in a building where moisture content of air is not controlled, a two-part investigation of the occurrence of track fading in neutron film under use conditions was undertaken. The first part of the study measured the amount of fading, and the second part followed variations of fading over an extended period of time. (auth)

4843 SOURCE OF ERROR IN THE APPLICATION OF THE FRICKE DOSIMETER. Macfarlane, J. J. (CSIRO, Ryde, New South Wales); Reeve, R. F.; Spragg, W. T. Int. J. Appl. Radiat. Isotop., 19: 883-5(Dec. 1968).

From studies of the radiation chemical production of ozone it seemed possible that high results might be obtained when the Fricke radiation dosimeter is used under a head-space of air. In this case, in addition to ozone, nitrogen oxides could also contribute to the effect. Experiments are described which show that under such a condition a significant error can be introduced. (auth)

4844 HEATING RATE CONTROLLER FOR THERMOLUMINESCENCE STUDIES. Harris, A. M.; Jackson, J. H.; Walker, W. N. (Central Electricity Generating Board, Berkeley, Eng.). J. Phys., E (London), 1: 1134-5(Nov. 1968).

A linear heating rate temperature controller for use in thermoluminescent studies is described. It provides a range of heating rates from 0.2 to 100°C s^{-1} with a deviation from linearity of no more than 0.2°C. It is capable of operating up to temperatures of 750°C. (auth) (UK)

4845 RESIN COMPOSITION FOR RADIATION DOSIMETRY. Tsukada, Tomomichi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1968-12007. May 21, 1968. Filed Oct. 23, 1964.

A resin composition suitable for radiation dosimetry at small doses is composed of a chlorine-containing polymer, such as vinyl chloride or vinylidene chloride polymer, which has been suitably molded, a small quantity of an acidic-sensitive dye, and an agent to accelerate dissociation deterioration of the polymer. The resin composition is simple to prepare simple to handle, and easily indicative of radiation doses. (NSA of Japan)

4846 PROCESS FOR THE PRODUCTION OF A LITHIUM FLUORIDE STORAGE PHOSPHORESCENT SUBSTANCE. Frank, Manfred; Edelmann, Bernd-Udo (to Veb Vakutronik Wissenschaftlicher Industriebetriebe Dresden). British Patent 1,126,777. Sept. 11, 1968. Filed Apr. 15, 1966.

A lithium fluoride phosphor having a glow maximum of thermoluminescence at 200°C is produced by precipitating LiF out of HF and LiCl, adding a soluble Mg salt to the jelly-like precipitation product corresponding to 0.01 to 0.03 wt % Mg, washing the product, and heating it in air for 10 to 60 min at 600 to 650°C. The LiCl used for the precipitation must have a Ca content of more than 0.01 wt %. The LiF prepared by this method is suitable for use as a radiation dosimeter, and before the first radiation measurement the material is exposed to 50 to 250 kR and subsequently heated to 280 to 320°C for 1 to 3 hr. (B.L.M.)

4847 DOSE RATE MEASURING DEVICE WITH A PROPORTIONAL COUNTER AND ELECTROSTATIC RELAY FOR DIGITAL DOSE MEASUREMENT. Pawelzik, J. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 10: 567-71(Oct. 1968). (In German and English).

A portable device for measuring low dose rates with automatic digital registration is described. The device includes an indication printing register, a printer, a preset time scaler and a repeat device, and makes it possible to determine average dose rates in the background range with considerable accuracy. The pulse frequency in measuring range I is almost linear from the background level up to 50 mR/h and, in measuring range II, after switching over the high voltage, from 50 mR/h to 150 R/h. The detector unit may be connected to the indicating unit by a cable up to 1000 m long without affecting accuracy. The device is suitable for environmental and area radiation monitoring. (auth)

4848 RAPID ASSESSMENT OF PULSED NEUTRON DOSES BY AN ENERGY-INDEPENDENT FOIL ACTIVATION SYSTEM. Block, S. (Univ. of California, Livermore). Health Phys., 16: 93-8(Jan. 1969).

A neutron dosimetry system has been developed that has a moderator configuration designed to allow measurement of multiple collision (surface absorbed) dose equivalent rate (rem/hr) independent of the neutron energy from thermal to 15 MeV. The response of this neutron dose meter closely follows the dose equivalent rate per unit flux density vs. energy curve taken from multiple collision data. An experimental study of this system, which employs gold foils, is described. (UK)

4849 A NEW APPROACH FOR DETERMINING QUALITY FACTOR AND DOSE EQUIVALENT IN MIXED RADIATION FIELDS. Pszona, S. (Inst. of Nuclear Research, Swierk, Poland). Health Phys., 16: 9-11(Jan. 1969).

The application of an organic scintillation detector and a tissue equivalent ionization chamber as a conjugate detector system for quality factor and dose equivalent determination in mixed radiation fields is described. QF determinations were made (as a function of depth in a slab phantom) for the incidence of 14.8 MeV neutrons and mixed radiation from a Po–Be source. (auth) (UK)

4850 BERYLLIUM OXIDE AS A THERMOLUMINESCENT DOSIMETER. Tochilin, E.; Goldstein, N.; Miller, W. G. (Naval Radiological Defense Lab., San Francisco). Health Phys., 16: 1-7(Jan. 1969).

The following dosimetric properties were observed in sintered BeO disks and powder: high thermal sensitivity and wide dynamic range, little energy dependence at low x-ray energies, low fast and thermal neutron thermoluminescence response, and good stability at room temperature. Thermoluminescence is principally in the ultraviolet and can be optically stimulated by visible light. The response is linear from 10 mR to 50 R and can be measured up to 10^3 R. (auth)

Radiometric Instruments

4851 INDUSTRIAL MEASURING METHODS WITH RADIOACTIVE ISOTOPES. Bierwolf, Helmut; Burbach, Werner. Tech. Mitt. AEG–Telefunken, 58: 340-9(1968). (In German).

The measurement technique using radioactive isotopes has obtained a firm position for industrial applications. Owing to noncontact gaging methods, measurements can be carried out at high precision and, above all, without the influence of the measuring tools. Many of these measurements are in general not possible using other methods. The users have thoroughly exhausted their initial considerations against the use of radioisotopes; accordingly it is understood that the application is safe when adhering to the protective regulations, and that the protective regulation is none other than an evaluation of the training and operational practices of the past ten years. (tr-auth)

4852 METHOD FOR MEASURING CONTINUOUSLY THE CEMENT-CLINKER VOLUME BY MEANS OF PENETRATING RADIATION. Ishii, Tokuhiko (to Nippon Cement Co., Ltd.). Japanese Patent 1968-16534. July 12, 1968. Filed Feb. 14, 1964.

A method is proposed using penetrating radiation whereby the volume of cement clinker can be measured accurately and continuously. It consists of the following: a device for controlling the particle-size distribution of clinker; a vessel below it, containing the packed layer of clinker; a radiation source and its detector, located on the outside of the vessel, opposite to each other; the entrance of clinker to the vessel; the exit to the vessel; and the clinker overflow outlet, to the vessel, located at the position above the source and detector. (NSA of Japan)

Miscellaneous Instruments and Components

Refer also to abstracts 4766 and 5792.

4853 (NAA-SR-Memo-11848) A METHOD OF DETECTING THE PRESENCE OF NaK IN AN INERT ATMOSPHERE UNDER CONDITIONS OF AMBIENT PRESSURE AND TEMPERATURE. Henley, H. L. (Atomics International, Canoga Park, Calif.). Feb. 18, 1966. 17p. Dep. CFSTI.

A very thorough investigation of devices and techniques revealed no means whereby the presence of minute particles of NaK could be detected in an inert atmosphere at conditions of ambient pressure and temperature. Therefore, a developmental program was conducted at Atomics International in an attempt to devise a method either direct or indirect–that could guarantee positive identification in a period of milliseconds. At conditions of ambient temperature and pressure the evaporation of NaK is nil. Consequently, it was found that an indirect detection method had to be used. The method which was developed simply consists of introducing methyl alcohol vapor to the inert blanket surrounding the NaK filled specimen. In the event that a leak develops, the alcohol immediately reacts chemically with the NaK to liberate hydrogen. Hydrogen sensors (specially developed for this program by the Beckman Instrument Company) strategically placed throughout the enclosure indicate the presence of hydrogen (and thereby also NaK) in milliseconds and perform this function with a content

of methyl alcohol vapor of approximately 0.2 parts per million parts argon. This amount of vapor has been found by experimentation to be adequate for detection purposes and yet was shown by test to be of insufficient quantity to result in damage to any of the materials utilized in the SNAP 10A construction. (auth)

4854 (NBS-TN-277) ANALYTICAL MASS SPECTROMETRY SECTION: INSTRUMENTATION AND PROCEDURES FOR ISOTOPIC ANALYSIS. Shields, William R. (ed.) (National Bureau of Standards, [Boulder, Colo.] Inst. for Materials Research). July 25, 1966. 99p. GPO $0.60.

This report describes the general instrumentation of the Analytical Mass Spectrometry Section and the specific analytical techniques which have been devised for the measurement of isotopic ratios of Ag, Br, Cl, Cr, Cs, Cu, Mg, Pu, and U. Interim procedures for B, Li, Rb, and Sr are also given. In the appendix some general statistical principles used in the design and analysis are briefly discussed. An example is given in detail illustrating the various steps involved leading from original data to the reported uncertainties for the isotopic ratio of bromine. (auth)

4855 (NYO-3661-13) A STUDY ON CROSSOVER AND LEADING EDGE TIMING METHODS. Tao, S. J.; Ogata, A. (New England Inst. for Medical Research, Ridgefield, Conn.). Sept. 1968. Contract AT(30-1)-3661. 18p. Dep. CFSTI.

The practical resolutions obtained from both crossover and leading edge timing methods are compared with their theoretical resolutions. Practical resolution of about 200 psec may be obtained from both methods. However, for large dynamic range, crossover timing is superior. (auth)

4856 (UCRL-18301(Rev.)) ESSENTIAL NONLINEARITY OF PHASE-SENSITIVE DETECTOR CHARACTERISTICS. Leskovar, Branko (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1968. Contract W-7405-eng-48. 9p. (CONF-681021-1). Dep. CFSTI.

From 6th Allerton on Circuit and System Theory Conference, Urbana, Ill.

The effect of essential nonlinearity of detector characteristics in a phase-sensitive detection system is studied and determined theoretically in detail over a wide dynamic range of optimum and nonoptimum operating conditions, assuming that the input signal is in the narrow-band Gaussian noise. Minimum, maximum, and limiting values of nonlinearities of detector characteristics are determined by means of computer-aided analysis. (auth)

4857 HELIUM COOLED RADIO FREQUENCY PREAMPLIFIER FOR USE IN NMR. Miyoshi, D. S.; Cotts, R. M. (Cornell Univ., Ithaca, N. Y.). Rev. Sci. Instrum., 39: 1881-4(Dec. 1968).

A low temperature (4.2 K) radio-frequency amplifier has been constructed using metal oxide semiconductor field effect transistors (MOSFET). Noise characteristics of the amplifier are compared to a model that includes two noise sources: shot noise and induced gate noise. The model is similar to models used to represent noise in vacuum tubes. Amplifier use for observation of low temperature nuclear magnetic resonance (NMR) signals is considered. Conditions for optimum signal-to-noise (S/N) are expressed in terms of the noise figure and are compared to those for room temperature vacuum tube amplifiers. Improvement of S/N by factors of 3 to 10 are readily obtainable. The S/N improvement with the low temperature MOSFET amplifier is demonstrated by observation of the NMR signal of ^{205}Tl at 4.2 K at a frequency of 20 MHz. (auth)

4858 SIMPLE METHOD OF PREPARING MAGNESIUM OXIDE SECONDARY EMISSION SURFACES. Iversen, R. J.; Gaddy, O. L. (Univ. of Illinois, Urbana). Rev. Sci. Instrum., 39: 1950-1(Dec. 1968).

A method is described for obtaining MgO secondary emission surfaces prepared by air baking a metallic substrate which has been dipped in a solution of magnesium methylate [$Mg(OCH_3)_2$] and methyl alcohol. (B.G.D.)

4859 MASS DISCRIMINATION IN A TIME-OF-FLIGHT MASS SPECTROMETER. I. GEOMETRIC MASS DISCRIMINATION AT MAGNETIC ELECTRON MULTIPLIER. Hunt, W. W. Jr. (Air Force Cambridge Research Labs., Bedford, Mass.); McGee, K. E.; Streeter, J. K.; Maughan, S. E. Rev. Sci. Instrum., 39: 1793-9 (Dec. 1968).

The magnetic electron multiplier widely used as the particle detector in time-of-flight (TOF) mass spectrometers can introduce several mass discrimination effects. One, geometric mass discrimination, arises from ions being deflected by the magnetic field so that the multiplier entrance apertures intercept a mass-dependent fraction of the incoming ions and prevent their being detected. A method of correcting for geometric mass discrimination in linear TOF instruments is outlined and used to compute correction factors for the specific geometry and magnetic field configuration that characterize our modified TOF mass spectrometer. The results indicate that, except perhaps for H^+ and H_2^+, geometric mass discrimination is negligible in most commercial TOF instrumeats when they are operated at the normal 3000 V accelerating potential. Geometric discrimination can become serious, however, if the instrument is operated at accelerating potentials significantly below normal, since the amount that an ion bunch is deflected increases as its kinetic energy, as well as its mass-to-charge ratio, decreases. For this same reason, geometric discrimination against fragment ions formed in the drift tube can be quite serious even when the instrument is operated at accelerating potentials higher than the normal 3000 V. (auth)

4860 HYDROGEN PLASMA DECAY MEASURED BY DOUBLE MICROWAVE INTERFEROMETER. Brand, G. F. (Univ. of Sydney). Rev. Sci. Instrum., 39: 1945-6(Dec. 1968).

A 120-GHz microwave interferometer was incorporated in a double interferometer in order to probe a region of plasma at two frequencies simultaneously. Peak electron densities from 10^{12} to 1.8×10^{14} cm^{-3} were measured and compared with spectroscopic measurements. (B.G.D.)

4861 INSTRUMENTATION AND MEASUREMENT OF NUCLEAR MAGNETIC TRIPLE RESONANCE INCLUDING ^{14}N RESONANCE. Chem. Instrum., 1: 33-46(July 1968).

A bridge-type high-resolution NMR spectrometer was modified to provide a triple-resonance spectrometer which decoupled 2 kinds of interaction, $^{14}N-^{1}H$ and $^{1}H-^{1}H$. The instrumentation of this modification is described in detail. The conditions for decoupling the ^{14}N interaction with proton were investigated experimentally, especially the dependence of the proton resonance resolution on both power and frequency of the rf field corresponding to the ^{14}N resonance. It is pointed out that the resonance frequency of the ^{14}N nucleus can be measured with high accuracy using this double-resonance technique. The triple-resonance technique was applied to pyrrole, and was successful in spin couplings to the interactions between specified groups of proton. (BBB)

4862 TROMBAY AUTOMATIC DIFFRACTOMETERS: A SEMI-AUTOMATIC NEUTRON DIFFRACTOMETER (SAND). Chidambaram, R.; Sequeira, A.; Momin, S. N. (Bhabha Atomic Research Centre, Trombay, India). Indian J. Pure Appl. Phys., 6: 550-2(Oct. 1968).

A neutron diffractometer which can scan automatically up to 20 zero-layer reflections from a single crystal is described. It uses an electromechanical system of automation to set the crystal angle for successive reflections to an accuracy of better than ±2 min of arc. (auth)

4863 APPARATUS FOR REFLECTIVITY MEASUREMENT OF REACTIVE AND RADIOACTIVE MATERIALS. Jones, J. M. (Univ. of Newcastle upon Tyne, Eng.); Murchison, D. G.; Scott, E.; Pickles, S. J. Roy. Microscop. Soc., 88: 503-12(Nov. 1968).

A Leitz Epilux microscope with inclined binocular and vertical monocular tubes was installed in a glove box to allow reflectivity measurements on radioactive materials or samples requiring the protection of an inert atmosphere. Focusing arrangements involving only the stage of the microscope are a requirement of the system. By breaking the microscope immediately above its limb and below the tube division, versatility of the instrument was retained without disturbing the optical path. Reflectivities can be measured with the equipment on areas with diameters as small as 4 μm using approximately monochromatic light. Measuring procedures are similar to those employed with reflectivity systems on the open bench, but some modification of technique is required. Since the glove box must be maintained at a small positive pressure, it is important to restrict as far as possible hand movements which affect the pressure level and so cause variation in the focus of the microscope through distortion of the box. While reflectivity measurements using the box are more time-consuming than with more conventional systems, high accuracy and reproducibility can be attained. (auth)

Radiation Effects on Instruments and Instrument Components

4864 (HMI-B-73) INVESTIGATION OF THE CHANGE OF ELECTRICAL PROPERTIES OF THE SILICON SOLARCELL BPY 70 BY MEANS OF NEUTRONS, ELECTRONS, γ-, AND X-RAYS. Dahlen, P.; Spencker, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Aug. 1968. 23p. (In German). Dep.

Radiation damage of the n-p-Si-solarcell BPY 70 regarding ionization and displacement effects by nuclear reactor neutrons, 1.5 MeV-electrons, gamma-rays (^{60}Co), and x-ray radiation of 100 keV energy limit is reported. Measurements of short circuit current, open circuit voltage, maximum efficiency and spectral photosensitivity are accomplished. Diffusion length of minority carriers is evaluated from spectral photosensitivity by means of collection efficiency and the appropriate damage factor is given. Partial anneal of radiation damage is observed for high absorbed dose of neutrons (>10^{15} n · cm^{-2}). Nuclear conversion of dopant boron into lithium, which is caused by the flux of thermal neutrons of the nuclear reactor may explain it. (auth)

4865 (HMI-B-74) CHANGE OF ELECTRICAL PROPERTIES OF INTEGRATED CIRCUITS BY NEUTRON, ELECTRON, AND γ-RAY IRRADIATION (^{60}Co) (RTL-FAMILY:NOR GATE FBH 100). (Paxmann, P.; Spencker, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Aug. 1968. 37p. (In German). Dep.

A survey of the physical and electronic behavior of a NOR-gate of the RTL family is given, and radiation damage by means of ionization and displacement effects are discussed. Measurements of the following quantities and their change by irradiation are discussed: dc current gain, junction leakage currents; I_B-U_{EB} - characteristics of the transistors; resistors; input and output currents; logical 0; transfer function; and transient response of the device. The reduction of current gain because of displacement effects causes failure of the NOR gate. Ionization effects (^{60}Co) do not degrade gate performance substantially. (auth)

4866 EFFECTS OF IRRADIATION IN A REACTOR ACTIVE ZONE ON THE QUARTZ PLATE OSCILLATION FREQUENCY. Lobanov, E. M.; Chubarov, L. B.; Zverev, B. P. Radiotekh. Elektron., 13: 1864-6(Oct. 1968). (In Russian).

Effects of submicroscopic amorphous regions, formed in neutron-irradiated crystalline quartz, on the variations in oscillation frequencies of quartz plate, and, in particular, of V−T and A−T shears, were studied. The O. Sh. Grois method was used to account for the influence of inclusion of impurities on the changes in the density and resilience of quartz. Equations obtained for oscillation frequency variations in oblique shear plates irradiated by reactor neutrons, describe the attenuation of oscillation frequency in VT-shear plates and the increment of oscillation frequencies of AT plates. (tr-auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 4906, 4945, 4951, 4980, 4990, 5016, 5018, 5019, 5025–5027, and 5058.

4867 (CU–2530–13) MINERAL HOMEOSTASIS AND SKELETAL METABOLISM. Clark, Irwin (Columbia Univ., New York. Coll. of Physicians and Surgeons). Sept. 27, 1968. Contract AT(30-1)-2530. 22p. Dep. CFSTI.

Studies on removal of skeletally bound radiostrontium revealed that magnesium ions increased urinary radiostrontium to a greater extent than adrenal cortical steroids, vitamins A and D, or parathyroid hormone. It was found that supplemental magnesium was very effective in increasing calcium absorption from the intestine and although it also caused a slight hyper-calciuria, the net effect was a marked increase in calcium balance. It was also observed that supplemental magnesium markedly decreased urinary phosphate and its effect on phosphate absorption was dependent on the dietary level of phosphate; the net result was a significant increase in phosphate balance. Studies on the combined use of vitamins A and D showed that toxic amounts of vitamin A, when administered concomitantly with excessive amounts of vitamin D, ameliorated the symptoms of hypervitaminosis. Vitamin A increased longevity and improved the histologic appearance of the osseous structures of hypervitaminotic D rats. To study the role of vitamin D in intestinal absorption of calcium, the capacity of isolated mucosal cells for taking up ^{45}Ca from an incubation medium was determined. It was found that mucosal cells from animals deprived of vitamin D or fed excessive amounts of the vitamin accumulated more calcium than cells from control animals. Studies in vivo showed that there was a delay in the transfer of ^{45}Ca from intestine to blood of avitaminotic D rats and an accelerated transfer of the isotope in hypervitaminosis D. Using radioactive and non-radioactive tetracycline (TC), studies were conducted on the binding of TC to bone. It was found that TC moved with the protein and not with the mucopolysaccharide. Results suggested that TC binds to a non-collagen protein in bone and that this protein may be involved in the initial steps in ossification. Studies were conducted on the role of lysosomal enzymes in articular cartilage degeneration. In experiments with rats on calcium and phosphate metabolism it was found that parathyroidectomy had no significant effect on net calcium absorption or calcium balance over a twelve day period. Parathyroidectomy decreased net phosphate absorption. Effects of adrenal cortical steroids on calcium, magnesium, and phosphate metabolism were studied using normal, adrenalectomized, and hydrocortisone treated rats. Adrenalectomy caused an immediate fall in urinary calcium that persisted for 14 days. Hydrocortisone had no effect on urinary calcium but decreased fecal calcium significantly. Urinary phosphorus was slightly depressed by adrenalectomy and significantly increased by hydrocortisone treatment. Other studied were conducted on interrelations between the parathyroid and adrenal glands and on endocrine-magnesium interrelations. (H.L.W.)

4868 (ORNL–tr–2016) EXCHANGE OF ^{32}P IN TISSUES AND ORGANS UPON SINGLE AND MULTIPLE INHALATIONS. Pugachevskii, V. P. Translated by K. S. Warren, George Moore, and Martha Gerrard (Oak Ridge National Lab., Tenn.), from Med. Radiol., 11: No. 12, 60–2(1966). 3p. Dep. CFSTI.

An hour after a single administration of ^{32}P to rats by inhalation, 75 to 90% of the isotope was resorbed into the blood. Phosphorus-32 was eliminated from the organs and tissues according to a complex exponential relationship. The accumulation of ^{32}P following both chronic and single intake is satisfactorily represented by a complex exponential equation. Radiobiological parameters found for a single intake of ^{32}P may be used for estimating chronic intake of the isotope into the organism. (auth)

4869 BIOCHEMICAL CHANGES IN THE LUNGS OF RABBITS AFTER INHALATION OF PLUTONIUM. Tseveleva, I. A.; Libinzon, R. E.; Mushkacheva, G. S.; Rysina, T. N.; Surina, A. G. (Inst. of Biophysics, Moscow). Radiobiologiya, 8: 535-41(1968). (In Russian).

The metabolism of lung tissue after a single inhalation of ammonium plutonium pentacarbonate by rabbits in a dose producing sclerotic changes in the lungs, was investigated. A single inhalation of ammonium plutonium pentacarbonate at a dose of 0.5 μCi/g of lungs led to substantial changes in the metabolism of various compounds in the lung tissue. The metabolic processes in the lungs were sharply directed toward fibrillogenesis from the first month after the treatment on. This was evidenced by an increase in the content of hydroxyproline (up to 114 to 125%) and mucopolysaccharides (up to 135 to 140%), that was already noted two weeks to one month after inhalation. From three months on, a more intensive incorporation of ^{35}S into the sulfated mucopolysaccharides was observed. The most substantial changes during the first periods of investigation were noted in the lipids, phospholipids, and sialic acids. The content of these substances two weeks after inhalation was 185, 240, and 164% of the control, respectively. (JPRS)

4870 COMPARISON BETWEEN THE INHIBITORY EFFECT OF PERCHLORATE ON IODIDE AND PERTECHNETATE CONCENTRATIONS IN SALIVA IN MAN. Harden, R. McG.; Alexander, W. D.; Shimmins, J.; Robertson, J. W. K. (Western Infirmary, Glasgow). Quart. J. Exp. Physiol., 53: 227-38(July 1968).

The inhibitory effect of the ClO_4^- ion on the concentration of ^{132}I and $^{99m}TcO_4^-$ was studied in human parotid saliva, collected under resting conditions and during stimulation. The saliva/plasma (S/P) ^{132}I and $^{99m}TcO_4^-$ ratios and the salivary I and TcO_4^- clearances fell after ClO_4^- administration. The percentage fall in the S/P ratios was greatest under resting conditions. There was a linear inverse relation between the S/P ratios and log dose of ClO_4^- at doses of 3 mM/day and greater. I^- and TcO_4^- were not inhibited to the same extent by ClO_4^-. The ratio of the salivary I^- to TcO_4^- clearance, measured simultaneously, was higher after ClO_4^- administration. The dose of ClO_4^- corresponding to inhibition of the S/P TcO_4^- ratio to half the control value was less than the dose required for a corresponding decrease in the S/P I^- ratio. The dose of ClO_4^- required to depress the S/P I^- and TcO_4^- ratios to 50% of the control value and to an absolute value of 0.5 was compared to the equivalent dose of I. The ClO_4^- was a more potent inhibitor of the salivary I-concentrating mechanism than given in molal equivalent doses. However, in contrast to ClO_4^-, I^- depressed the S/P I^- and TcO_4^- ratios to the same extent. Although TcO_4^- shared with I^- one common transport mechanism, there were also differences in the transport of the ions from the blood into the saliva. (BBB)

4871 EFFECTS OF γ-IRRADIATION ON GLYCOLYTIC CONTROL MECHANISMS IN EHRLICH ASCITES TUMOR CELLS. Yamada, Takeshi (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res., 9: 41-9(June 1968).

Intracellular concentrations of intermediates and cofactors of glycolysis were measured in γ-irradiated Ehrlich ascites tumor cells. Changes in the levels of intermediates and comparison of mass-action ratios with the equilibrium constants for the reactions of glycolysis revealed a remarkable enhancement of phosphofructokinase activity and inhibitions at the triosephosphate dehydrogenase and pyruvate kinase steps. The possible mechanisms involved in the alteration of these regulatory enzymes in glycolysis are discussed. (auth)

4872 RADIOSENSITIVITY OF THE HYDROGEN BOND IN DNA. Ullrich, M.; Hagen, U. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Naturforsch., 23b: 1176-83(Sept. 1968). (In German).

Calf thymus DNA was irradiated in aqueous solution by ^{60}Co γ rays and fractionated on columns of kieselgur with methylated serum albumin (MAK). Irradiated DNA was firmly bound by the MAK-column in neutral pH, exponentially to the radiation-dose; it could be eluted, however, with a 2 N-ammonia. There is only a limited region of the DNA-molecule that is responsible for the retention, as the irradiated DNA-molecules could be degraded by ultrasound to fragments which are retained by the column and to those which can be eluted. Experiments with DNA, degraded by DNAse or ultrasound, have shown, that breaks of the double helix or breaks of a single strand are not responsible for this retention. Crosslinks between the molecules or alterations of the nucleotide bases could as well be excluded. The sensitivity of the DNA concerning the observed radiation effect depends on the ionic strength of the solution during irradiation. In 0.4 M NaCl, where the helical structure of the DNA is more stable, the radiosensitivity is lower than in 0.01 M NaCl. This leads to the conclusion, that short single stranded regions are formed by irradiation and are responsible for the binding by the column. The denatured regions in irradiated DNA can not be recognized, however, by alteration of absorbancy-temperature relationships. The size of these regions in the DNA-chain and the mechanism of their formation is discussed. (auth)

4873 THERMOSTIMULATED EXOELECTRONIC EMISSION OF HEMOGLOBIN, ASSOCIATED WITH CERTAIN AMINOTHIOLS. Vladimirov, V. G.; Vladimirov, G. G. (Leningrad State Univ.). Radiobiologiya, 8: 610-12(1968). (In Russian).

The effect of thermostimulated exoelectronic emission (TSEE) was produced in mixed disulfides, formed from hemoglobin, β-mercaptoethylamine, hemoglobin, and 5-mercaptopentylamine. The nature of the TSEE in the investigated preparations had its own peculiarities in each case. After irradiation of the preparations at a dose of 10 kR, the picture of the TSEE changed; the intensity of the maxima of the TSEE depended upon the chemical structure of the aminothiol bonded to the protein. (JPRS)

4874 DYNAMICS OF THE ACCUMULATION AND ELIMINATION OF ^{90}Sr FROM THE RAT SKELETON DEPENDING UPON THE AGE OF THE RATS IN CHRONIC EXPERIMENTS. Shvedov, V. L. (Inst. of Biophysics, Moscow). Radiobiologiya, 8: 632-5 (1968). (In Russian).

A study of the principles of the accumulation and elimination of ^{90}Sr from the organism in the case of chronic intake of the isotope during the embryonic and postnatal periods of development indicated that the increase in the total activity of the skeleton parallels its growth. The decrease in the specific activity of the bone corresponded to the rate of elimination of the isotope from the skeleton. (JPRS)

4875 INVESTIGATION OF DISTURBANCES OF PROTEIN SYNTHESIS IN MICROSOMAL SYSTEMS DURING ACUTE RADIATION SICKNESS. D'yachenko, A. G.; Moskalenko, I. P.; Todorov, I. N. (Kharkov Scientific Research Inst. of Medical Radiology). Radiobiologiya, 8: 507-9(1968). (In Russian).

Disturbances of protein synthesis were studied in cell-free systems containing microsomes and cell fluid from the livers and spleens of normal and irradiated animals. The detected changes in protein synthesis at all periods of investigation after irradiation (after 2, 12, and 24 hrs) were associated chiefly with the microsomal fraction, while the changes after 12 hrs were also associated with the cell fluid. (JPRS)

4876 RADIOIMMUNOASSAY OF CALCITONIN: A PRELIMINARY REPORT. Arnaud, Claude D.; Littledike, Travis; Tsao, Hang S.; Kaplan, Edwin L. (Mayo Clinic, Rochester, Minn.). Mayo Clin., Proc., 43: 496-502(July 1968).

The development of a radioimmunoassay procedure for the measurement of a porcine thyroid polypeptide which may be calcitonin is reported and described. The calcitonin standard, calcitonin antisera, and technique of radioimmunoassay are described briefly. The ^{131}I labeling of calcitonin, animal infusion procedures, and details of the radioimmunoassay procedures are also discussed. The radioimmunologic procedure can easily detect 100 μU (MRC-A) in 1 ml of incubation mixture. The calcitonin preparation used as a standard and for iodination with ^{131}I was homogeneous by a number of critical criteria, and the antisera prepared in guinea pigs against a crude preparation of calcitonin bound at least 90% of the labeled purified polypeptide. The standard curves obtained with three different stable antigens consisting of crude calcitonin, purified calcitonin, and endogenous calcitonin (immunoreactive material which appeared in porcine thyroid vein plasma during induced hypercalcemia) were virtually superimposable. Complete displacement of calcitonin-^{131}I from antibody was observed when the incubation mixtures contained large concentrations of these antigens. The levels of calcitonin measured by bioassay and immunoassay in thyroid vein plasma containing large amounts of endogenous calcitonin were similar. (BBB)

4877 CHANGE IN THE HISTAMINE-HISTAMINASE SYSTEM AFTER CHRONIC ADMINISTRATION OF A MIXTURE OF RADIONUCLIDES. Zapol'skaya, N. A.; Fedorova, A. V. (Leningrad Scientific Research Inst. of Radiation Hygiene). Radiobiologiya, 8: 615-18(1968). (In Russian).

Kinetics of the changes in the histamine-histaminase system in the blood and tissues of the liver, kidneys, and intestines under the action of a mixture of radioisotopes upon the organism were studied. When a mixture of radioisotopes was administered, an increase in the histamine content of the blood and tissues was observed. The time of appearance and intensity of the response depended upon the concentration of the mixture introduced. An increase in the activity of histaminase in the initial period of administration of the mixture was noted in the animals of all the groups, while a phase of inhibition of activity was noted only among the animals that received the mixture of isotopes with the highest activity. (JPRS)

4878 INFLUENCE OF FOLIC ACID ON NUCLEIC ACID COMPOSITION OF BRAIN IN NORM AND AT RADIATION LESION. Sopin, E. F.; Kucherenko, M. E. (Lenin State Univ., Kiev). Ukr. Biokhim. Zh., 40: 388-93(1968). (In Ukrainian).

The ratio of nitrogen components of RNA and DNA was studied in the guinea-pig brain during acute radiation disease and with injection of folic acid into x-irradiated and normal animals. Paper electrophoresis in combination with ultraviolet spectrophotometry were used to determine nucleic acid composition. It was established that folic acid possesses distinctly pronounced antiradiation properties. When injected into the irradiated animals the disturbances in the ratio of RNA nucleotides and DNA nitrogen bases were normalized. Injection of folic acid into the normal animals did not affect the qualitative composition of brain nucleic acids. The possible mechanisms of antiradiation effect of folic acid are discussed. (auth)

4879 CELLULAR KINETICS OF THE IMMUNE RESPONSE. Gregory, Constance J. (Christie Hospital, Manchester, Eng.). J. Physiol. (London), 197: 54P(July 1968).

The use of the heavily irradiated mouse for quantitative studies of the growth kinetics and differentiation of transplanted hematopoietic stem cells was adopted for the analysis of the properties of cells responsible for immunity in the mouse. Heavily irradiated $(C_3H \times AKR)F_1$ mice were grafted with normal syngeneic spleen cells and a standard number of sheep red cells as antigen. The appearance of antibody plague-forming cells (19S and 7S) in the spleen was followed for various graft sizes, and the peak number was correlated with corresponding measures of the number of clones of these cells. The results suggested that the proliferative capacity of the progenitor of the plague-forming cell clone increased with increasing graft size. (BBB)

4880 LOCALIZATION OF ^{197}Hg CHLORMERODRIN AND SODIUM ^{131}I IN THE FEMALE REPRODUCTIVE TRACT. Johnston, Gerald S.; Cruse, Joseph R.; McIlroy, William; Kyle, Ralph W. (Walter Reed Medical Center, Washington, D. C.). J. Nucl. Med., 9: 198-201(May 1968).

Three groups of women were studied to determine the radioactivity in the ovary and in the uterus after the intravenous administration of ^{197}Hg-chlormerodrin in two groups, and the oral administration of ^{131}I in the third group. The majority of the genital tissues studied contained radioactivity equal to or less than blood background with both isotopic agents. However, the maturing Graafian follicles contained significantly higher amounts of ^{197}Hg-chlormerodrin. Iodine-131, on the other hand, did not concentrate in the ovary nor in the follicles to a degree higher than that found in the blood. Although radioactive mercury chlormerodrin was not concentrated by the stomach, ^{131}I was present in gastric secretions in large amounts. Bathing the maturing ovum in follicular fluid that contains even these low levels of radioactivity may have some genetic significance. (auth)

4881 OKIS' TRITIYA. (Tritium Oxides). Moskalev, Yu. I. Moscow, Atomizdat, 1968. 396p.

Extensive theoretical and experimental data on the distribution, metabolism and biological effects of tritium oxide are collected in the book. Physical properties of deuterium and tritium, isotopic exchange of hydrotritium in biological media, aqueous exchange in the human and animal organisms, the rate of tritium oxide uptake by intestinal tract, lungs, and skin, and the kinetics of tritium excretion from animal organisms are discussed. Tissue doses and biological effects of tritium oxides are analyzed considering the doses and the rhythm of isotopic uptake. The clinical picture of injuries, immunology, kidney functions, and water-salt metabolism are described. Chronic effects and genetic effects are also discussed. Permissible air doses of tritium oxide and gaseous tritium in industry, biophysical properties of various tritium compounds and general toxicology of tritium oxide are evaluated. (R.V.J.)

4882 β-GLUCURONIDASE LEVEL IN IRRADIATED RAT LIVER. Covi, A.; Mandalis, C.; Superina, B. (CAMEN, Pisa, Italy). Boll. Soc. Ital. Biol. Sper., 44: 779-82(Apr. 30, 1968). (In Italian).

The behavior of the β-glucuronidase in the liver of rats exposed to a whole-body x-radiation dose of 1020 R was determined at 24, 48, 72, and 96 hrs and 7 days after irradiation. The results showed that the protein content remains constant in the first four days after irradiation, but there is a slight insignificant reduction by the 7th day. The enzymatic activity decreases significantly up to 48 hrs and then maintains an almost constant level with a modest insignificant increase on the 7th day. The specific activity follows the same pattern as the enzymatic activity. It is concluded that irradiation causes a marked decrease of the activity of the β-glucuronidase, which after 48 hrs is 60 to 70% of the activity of the controls. (tr-auth)

4883 GLUCOSE-6-PHOSPHATE DEHYDROGENASE LEVEL IN IRRADIATED RAT LIVER. Covi, A.; Superina, B. (CAMEN,

Pisa, Italy). Boll. Soc. Ital. Biol, Sper., 44: 783-4(Apr. 30, 1968). (In Italian).

Male white rats were exposed to whole-body x irradiation at a dose of 1020 R and the glucose-6-phosphate dehydrogenase level in the liver was determined 24 hrs after irradiation. The results are tabulated; the mean specific activity of the controls is 0.0514 ± 0.0059, whereas in the irradiated animals the mean value is 0.0492 ± 0.0045. The two means are not significantly different with a probability higher than 90%. This indicates that the specific activity of the glucose-6-phosphate dehydrogenase 24 hrs after irradiation has undergone no significant modifications with respect to the controls. (J.S.R.)

4884 INFLUENCE OF TOTAL BODY X-IRRADIATION WITH 800 R ON FOETAL AND MATERNAL LIPIDS IN RATS. Winkler, L.; Goetze, E. (Friedrich-Schiller Univ., Jena, Ger.). Acta Biol. Med. Ger., 20: 883-5(1968). (In German).

Twenty-four hrs after whole-body x radiation at 800 R there was a sharp increase of the triglyceride- and phosphate-containing linoleic acid quantity with unaltered concentration of the lipid fraction in the fetal plasma. In the maternal plasma lipids, only a decrease of the free and esterified cholesterol was detected after irradiation. These data, in relation to earlier studies, indicate an intact capacity of the fetal liver for the delivery of lipoproteins after irradiation. The fetal plasma lipids, in comparison with the maternal plasma lipids, are characterized by a higher content of free and esterified cholesterol and total phosphatides and a lower content of triglycerides. (tr-auth)

4885 RADIOIMMUNOASSAY FOR RAT LUTEINIZING HORMONE. Monroe, S. E.; Parlow, A. F.; Midgley, A. R. Jr. (Univ. of Michigan, Ann Arbor. Harbor General Hospital, Torrance, Calif. Univ. of California, Los Angeles). Endocrinology, 83: 1004-12(Nov. 1968).

A double antibody radioimmunoassay for rat luteinizing hormone (LH) has been developed. Purified rat LH (prepared by ammonium sulfate fractionation, ion exchange chromatography and gel filtration) with a potency equivalent to that of NIH-LH-S1 was iodinated with ^{131}I using chloramine-T. Antiserum capable of neutralizing rat LH, obtained by repeated immunization of rabbits with partially purified hormone, was absorbed with serum from hypophysectomized rats prior to use in the radioimmunoassay. Satisfactory dose-response curves were obtained with 0.0004 to 0.005 μg purified rat LH (90 to 20% bound). A variety of pituitary extracts with widely varying ratios of LH and follicle stimulating hormone (FSH) were bioassayed and radioimmunoassayed with the same standards in separate laboratories. In terms of NIH-FSH-S1 and NIH-LH-S1, pituitary extracts containing 1600 times as much FSH as LH, and, conversely, at least 10 times as much LH as FSH, were found to have potency estimates by radioimmunoassay which were in close agreement with bioassay values (indices of discrimination 0.79 to 1.3). Similarly, radioimmunoassay and bioassay estimates of the LH concentration of pituitary extracts containing LH: thyroid stimulating hormone (TSH) ratios which varied by more than 3000-fold were in good agreement (indices of discrimination 0.8 to 1.3). These observations suggest that FSH and TSH do not interfere with the measurement of LH by radioimmunoassay. Estimates of the concentration of LH in sera and serum extracts obtained by radioimmunoassay were lower than, but proportional to, estimates obtained by bioassay. (auth)

4886 ISOTOPES AND RADIATION TECHNOLOGY. Volume 6, Number 2. Baker, P. S.; Lafferty, Robert H. Jr.; Carden, Joan E.; Gerrard, Martha; Greene, R. E.; McKinney, F. E.; Miller, F. J.; Rupp, A. F. (eds.). One of the Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn., Oak Ridge National Lab., Winter 1968-69. 99p. GPO $0.70.

A review of significant developments in the fields of isotopes and radiation technology is presented. The review was prepared by the Isotopes Information Center, Oak Ridge National Laboratory and attempts to relate the published results of research and development sponsored by the Division of Isotopes Development to significant developments in radioisotopes and radiation technology, as reported in the literature. Separate abstracts were prepared for seven chapters. (H.L.W.)

For abstracts of individual papers see: 4670, 4672, 4767, 4787, 4788, 4904, and 4948.

4887 BIOCHEMICAL LESIONS INDUCED IN SUBCELLULAR STRUCTURES BY IONIZING RADIATION. VI. THE FORMATION OF LIPID PEROXIDES IN RAT LIVER. Dancewicz, Antoni M.; Mazanowska, Anna (Inst. of Nuclear Research, Warsaw). Nukleonika, 13: 709-18(1968).

Lipid peroxides concentration in liver subcellular fractions of rats irradiated with a dose of 750 R of x irradiation was determined by the thiobarbituric acid method at 0, 2 and 24 hours after exposure. Immediately after exposure the lipid peroxides content and the lipid peroxides formation during incubation were decreased in all preparations tested. Two hours after exposure particulate fractions (nuclear, mitochondrial and microsomal) showed an increase both in the content and in the lipid peroxides formation during incubation while the corresponding values for homogenates were still decreased in comparison to nonirradiated animals. This persisting decrease (found also 24 hours after exposure) was caused most probably by an antioxidant factor(s) present in the soluble part of the cytoplasm. The soluble fraction showed this antioxidant property, which did not disappear after dialysis and seemed to be even greater in preparations obtained from animals irradiated in vivo. (auth)

4888 STUDY OF IMMUNOLOGICAL RESPONSE BY ERNE METHOD IN INTACT AND IRRADIATED ANIMALS. Kartasheva, A. L.; Petrova, I. V. Zh. Mikrobiol., Epidemiol. Immunobiol., No. 6, 155(June 1968). (In Russian).

Dynamics of concentration of antibody synthesizing cells in the spleen was studied with hybrid August rats treated intraperitoneally with immunizing suspension of sheep erythrocytes (220×10^6 cells) and intact rats exposed to 500 R ^{60}Co γ irradiation. Observations of immunized rats revealed an increase in spleen weight and in the cell content (1½ to 2 times). The maximum increase reached on the 4th to 7th days was caused by the increase of lymphoid cells. Irradiation next day following the immunization revealed a slower concentration of antibodies without any sharp increase on the 5th day. Irradiation on the 5th day after immunization coincided with the maximum accumulation of the antibodies and on the 14 to 18th day the number of above cells increased considerably as compared with the control animals (78 ± 8 over 10^7 and 35.7 ± 7 over 10^7) respectively. During the same period the total number of spleen karyocytes was also increased. (R.V.J.)

4889 SUBCELLULAR LOCALIZATION AND IDENTIFICATION OF ALPHA EMITTERS BY ELECTRON MICROSCOPIC AUTORADIOGRAPHY. Adee, R. R.; Sanders, C. L.; Berlin, J. D. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Health Phys., 15: 461-3(Nov. 1968).

While investigating the distribution of $^{239}PuO_2$ particles in the peritoneal cavity of the rat, a method was devised to unequivocally identify and localize such particulate alpha emitters at the subcellular level. This information was required in order to properly evaluate the involvement of cellular organelles in radiation injury produced by $^{239}PuO_2$ particles that were phagocytized by the peritoneal cells. The method described was utilized only with $^{239}PuO_2$ particles; it would, however, be applicable in localizing and identifying any subcellular particulate alpha emitter. (auth) (UK)

4890 EFFECTS OF BODY SIZE ON ^{40}K MEASUREMENT IN THE WHOLE BODY COUNTER (TILT-CHAIR TECHNIQUE). Forbes, Gilbert B.; Schultz, Frank; Cafarelli, Genie; Amirhakimi, G. H. (Univ. of Rochester, New York). Health Phys., 15: 435-42(Nov. 1968).

The precision of ^{40}K determination in man by the "tilt-chair" technique is compromised by geometrical and self-absorption factors. In an attempt to improve calibration accuracy simultaneous measurements of ^{40}K and total body water (deuterium dilution) were made in 50 subjects of widely varying body size. The results show that neither height nor weight per se affects the observed body ratio of $^{40}K/H_2O$, and that the principal systematic error concerns the relative fat content of the subject. Correction of the observed ^{40}K values for this factor improves the accuracy of the measurement. (auth) (UK)

4891 DISTRIBUTION AND RETENTION OF ORALLY ADMINISTERED RADIOTUNGSTEN IN THE RAT. Kaye, Stephen V. (Oak Ridge National Lab., Tenn.). Health Phys., 15: 399-417 (Nov. 1968).

Two complementary experiments were performed to estimate the retention and gross distribution of radioisotopes of tungsten in the rat. The first experiment involved the measurement of ^{187}W in urine, feces, blood, plasma, GI tract, and residual carcass of 24 rats over a 3-day period. The second experiment was concerned with the distribution and retention of ^{185}W in major organs of 70 rats over periods of up to 254 days. The radiotungsten was administered by gavage in 1 ml of tungstate solution at pH 8 to adult Wistar rats. Urinary and fecal excretion each accounted for approximately 40% of the administered dose after 24 hr. Long-term studies of ^{185}W disclosed that after 100 days greater than 99% of the total body burden (about 0.4% of the administered dose) was retained in bone with a biological half-time of 1100 days for the slowest component of a three-component elimination curve. This half-time appears to be longer than previous studies have re-

ported, indicating that bone may be the primary site of damage from long-term retention of ^{181}W and ^{185}W. Elimination from soft tissues was relatively rapid, with highest concentrations during the first week in the following tissues: spleen, hair, kidney, uterus, liver, prostate, and ovary. (auth) (UK)

4892 RADIOACTIVE IRON STUDIES IN PATIENTS TREATED WITH METHOTREXATE FOR PSORIASIS. Petrou, P.; Lichtman, H. C.; Frank, L.; Biro, L. (State Univ. of New York, Brooklyn). Dermatologica, 137: 46-60(1968).

Four psoriatic patients were given radioiron intravenously to determine its clearance, utilization, and organ distribution before and after treatment with 50 mg of Methotrexate. There was no change in the ^{59}Fe plasma clearance in 2 patients, even when ^{59}Fe was injected 24 hr after Methotrexate (50 mg intramuscularly). In one patient there was a delay by a factor of half. Technical difficulties eliminated the fourth patient from the study. Following Methotrexate therapy, the organ uptake of ^{59}Fe shifted from the marrow to the liver and spleen (reservoir organs). A decrease in utilization of ^{59}Fe by red blood cells from an 80% (normal level) to 55% following Methotrexate injection occurred in 1 of 2 patients so tested. No significant or marked decrease in the peripheral blood elements was observed. (BBB)

4893 URINARY EXCRETION OF TRITIUM FOLLOWING EXPOSURE OF MAN TO HTO: A TWO EXPONENTIAL MODEL. Snyder, W. S.; Fish, B. R.; Bernard, S. R.; Ford, Mary R.; Muir, J. R. (Oak Ridge National Lab., Tenn.). Phys. Med. Biol., 13: 547-559(Oct. 1968).

Data on urinary excretion of tritium by a 41-year-old male who accidentally inhaled (or ingested) tritium, presumed to be in the form of HTO, are presented along with an interpretation of these data and an estimate of the radiation dose delivered to tissues. Measurements were made over 255 days after intake of the tritium. The data could be represented as a sum of two exponential terms, one with a half-life of about 9 days, the other of about 34 days. The total dose to body water was estimated to be about 16 Rem, the long-term exponential contributing about 2% of the total. A two-compartment model was applied to the data. Equations were derived for the amounts of tritium in each compartment, and an estimate was obtained for the total dose in any tissue, based on a comparison with the content of hydrogen in the tissue. This method of estimating the dose may be applicable for other radionuclides and their compounds. It assumes that the stable element and its radioactive isotope behave similarly in the body, but does not involve assumptions concerning the mathematical form of the retention function. (auth)

4894 INVESTIGATIONS WITH RADIOACTIVE COPPER (^{64}Cu) IN CHRONIC LIVER DISEASES. Wysocki, Kazimierz; Owczarek, Lucjan; Gorski, Szczesny; Kurnatowska, Aleksandra (Academy of Medicine, Poznan, Poland). Pol. Arch. Med. Wewn., 40: 377-83(1968). (In Polish).

Studies on ^{64}Cu metabolism were performed in patients with chronic liver diseases, especially Wilson's disease and in subjects without liver impairment, after intravenous injection of the isotope. Radioactivity was measured over the heart and liver. It was observed that in chronic liver diseases, particularly in Wilson's disease, the liver uptake of radiocopper is initially much lower than in normal subjects. At later hours this activity differs markedly depending on the type of cirrhosis and the type of Wilson's disease. Radioactivity curves over the heart in patients with a healthy liver showed a continuous increase at later times, while in Wilson's disease a decrease was seen. In cirrhosis, intermediate values were observed. (BBB)

4895 EFFECTS OF X IRRADIATION ON NICOTINAMIDE ADENINE DINUCLEOTIDE LEVELS IN RAT TISSUES. Ishikawa, Hajime (Tokyo Univ.). J. Fac. Sci., Univ. Tokyo, Sect. IV, 11: 281-91(Dec. 11, 1967).

The effects of whole-body x irradiation on the nicotinamide adenine dinucleotide (NAD) levels of rat liver, spleen, and thymus and on the NAD synthesis in liver and spleen after the administration of nicotinamide or nicotinate were studied. Irradiation of the rats with 500 R caused no significant changes in NAD levels of liver, spleen, and thymus. If rats were irradiated with 1000 R immediately before the injection of nicotinamide, the increased content of the liver NAD due to nicotinamide was markedly suppressed, while no such marked effects were observed in spleen NAD. The effects of x irradiation on the induced synthesis of the liver NAD were found to be dose independent at higher doses (>1000 R). Irradiation 4 to 24 hr before injection of nicotinamide and 2 to 10 hr after the injection had only negligible effects on the NAD synthesis. Induced synthesis of liver NAD due to the injection of nicotinate was also affected by irradiation, but a rapid increase in the liver NAD which occurred immediately after the injection was not reduced, but rather tended to be greater. The increase in spleen NAD after the injection was not as marked and was hardly affected by irradiation. (BBB)

4896 KINETICS OF FREE RADICAL CONCENTRATION IN VARIOUS ORGANS IN ANIMAL SUFFERING FROM RADIATION SICKNESS. Emanuel, N. M.; Saprin, A. N. Dokl. Akad. Nauk SSSR, 182: 733-4(1968). (In Russian).

Concentration of free radicals in various organs was studied using white male mice weighing 18 to 20 g x-irradiated with 750 R. Data obtained using EPR method showed an increase of free radicals. The increase in various organs differed. For instance, concentration of free radicals in spleen and blood was 2.5 times higher than in controls and in kidney and brain it was 2 times higher. The maximum concentration in the blood, brain, kidneys, and spleen was reached on the 3rd day and in the liver on the 5th day postirradiation. (R.V.J.)

4897 EFFECT OF CHRONIC X-RAY EXPOSURES ON INORGANIC PYROPHOSPHATASE ACTIVITY. Stefan, M.; Ghizari, E.; Stoenescu, R. Stud. Cercet. Fiziol., 13: 55-8(1968). (In Rumanian).

The influence of x-ray doses of 500 to 100 R delivered in an acute and chronic experiment, on the activity of inorganic pyrophosphatase in mouse liver homogenate was studied. The enzymatic activity decreased directly proportional to radiation intensity. Intraperitoneal glycine injections 3 hours prior to irradiation confer enzyme protection both in acute and chronic exposures. (auth)

4898 RADIOIMMUNOASSAY FOR OVINE, CAPRINE, AND BOVINE PROLACTIN IN PLASMA AND TISSUE EXTRACTS. Bryant, Gillian D.; Greenwood, F. C. (Imperial Cancer Research Fund, London). Biochem. J.; 109: 831-40(Oct. 1968).

A radioimmunoassay for ovine prolactin is described based on the inhibition of the reaction between ^{131}I-labeled ovine prolactin and guinea-pig or rabbit antiserum to ovine prolactin. The extent of the reaction after a 4-day incubation period is determined by chromatoelectrophoresis or by adsorption of unchanged ^{131}I-labeled ovine prolactin on charcoal. The sensitivity is equal to 5.9 ng of prolactin/ml of plasma with chromatoelectrophoresis, or 0.2 ng of prolactin/ml of tissue extracts with the charcoal separation. A complete cross-reaction demonstrated between ovine prolactin and caprine pituitary extracts allows the assay to be used to measure caprine prolactin. The partial cross-reactions between ovine prolactin and bovine prolactin and between ovine prolactin and bovine pituitary extract differ, and an alteration in the immunological activity of bovine prolactin during its isolation is suggested. Bovine prolactin in plasma may be measured against a bovine pituitary extract as standard. No cross-reactions were demonstrated with pituitary extracts from a number of other species. The extent of the contamination of ovine and bovine growth hormone preparations by their respective prolactins is shown. Dilutions of ovine and caprine plasma inhibit the reaction between ^{131}I-labeled ovine prolactin and antiserum with the same characteristics as ovine prolactin. The immunoreactive material in plasma fractionates on Sephadex G-200 and in sucrose density gradients as a single peak similar to that shown by freshly dissolved ovine prolactin. There is no evidence that ovine prolactin is bound to a plasma protein. By suppressing prolactin secretion and assaying serial samples of plasma thereafter it is shown that the immunological activity of the surviving hormone becomes progressively altered with time. It is suggested that this alteration is usually not detected but introduces an element of uncertainty into the quantitative but not the qualitative value of the measurements obtained by reference to standard ovine prolactin. (auth) (UK)

4899 THE EFFECT OF WHOLE-BODY X-IRRADIATION OF GUINEA PIGS ON LIVER RIBOSOMES. Hidvegi, E. J.; Holland, J.; Boeloeni, Elisabeth; Lonai, P.; Antoni, F.; Varteresz, V. (Inst. for Radiobiology, Budafok, Hungary). Biochem. J., 109: 495-505 (Oct. 1968).

The size distribution of aggregates of liver ribosomes and their protein-synthesizing ability in vitro were studied shortly after x irradiation of guinea pigs. Sucrose-density-gradient analysis of the mitochondrial supernatant after treatment with deoxycholate revealed a gradual increase in the number of polysomes, reaching a maximum between 9 and 15 hr after irradiation. At that period the amount of ribonucleoprotein particles reached a level 25 to 30% above the control. This finding was confirmed by analytical-ultracentrifugal analysis and electron microscopy. Experiments were conducted to exclude the possibility that the enrichment of polysomes in the irradiated animals had occurred during the isolation procedure. The protein-synthesizing ability of total ribosomal particles was measured in vitro. This showed an increase in amino acid incorporation parallel to the progressive enrich-

ment of polysomes. At radiation doses of up to 1000 R the protein-synthesizing capacity was dependent on the radiation dose: the higher the dose the higher the amino acid incorporation, reaching 40 to 60% above the control at the period of maximal polysome enrichment. Amino acid incorporation remained at this level after radiation doses of between 1000 and 3000 R. The enhanced protein-synthesizing activity was due solely to the increase in the proportion of polysomes, since irradiation was without effect on the activity of single ribosomes. The results of the experiments are discussed in the light of our knowledge of the effect of radiation on protein synthesis. (auth) (UK)

4900 INVESTIGATIONS ON BIOLOGICAL RADIATION PROTECTION. PART 87. THE INFLUENCE OF SULFUR-CONTAINING ORGANIC SUBSTANCES ON X-RAY-INDUCED RADICALS IN FREEZE-DRIED RAT LIVER. Moenig, Hans; Abd-el-Ghani, Ezz-Eldin M. (Univ., Freiburg i. B.). Strahlentherapie, 135: 731-8 (June 1968). (In German).

Freeze dried and evacuated rat liver was x-irradiated at room temperature; its ESR spectrum consisted of at least two components. A change in the radical states was observed after perfusion with air. It was assumed that molecular oxygen changed one alkyl radical into an alkoxy radical via a short lived hydroperoxide. Liver treated with sulfur-containing compounds (cysteine, homocysteine, homocysteine-thiolactone, and 5-mercaptopyridoxine) prior to freeze drying, showed an additional signal after irradiation in air; its maximum was at g = 2.016. This signal was attributed to a positive sulfur ion located on a mixed disulfide. The radical ion was probably formed by hydroxy radicals. 4-Mercaptopyridoxine, which has no radiation protective effect in animal experiments, gave only a very weak signal at g = 2.016 in irradiated liver. (auth)

4901 EFFECTS OF IRRADIATION AND CATABOLIC PROCESSES ON THE HALF-LIFE OF RAT SERUM ALBUMIN. Miltenyi, Laszlo; Adam, Geza; Jona, Gabor; Dezsi, Zoltan (Univ., Debrecen, Hungary). Strahlentherapie, 135: 745-7 (June 1968). (In German).

A new method for labeling serum albumin is described that uses ^{131}I-triiodobenzoic acid. This was used to study the influence of γ- and x-radiations and anabolic agents on protein metabolism in the rat. The biologic half-life was measured with a whole-body counter, that permits a precise analysis and determination of the protein synthesis. The influence of radiation on the biologic half-life is examined and discussed. The experiments show that an anabolic agent has almost no influence on the anabolism of serum albumin in the rat, but a marked effect on the catabolism. (auth)

4902 PROBLEMY RASPREDELENIYA I EKSPERIMENTAL'NOI OTSENKI DOPUSTIMYKH UROVNEI ^{137}Cs, ^{90}Sr, ^{106}Ru. (Problems of Distribution and Experimental Evaluation of Permissible Levels of ^{137}Cs, ^{90}Sr, and ^{106}Ru). Buldakov, L. A.; Moskalev, Yu. I. Moscow, Atomizdat, 1968. 296p.

A brief review is given of published data on distribution, exchange kinetics, and biological migration of ^{137}Cs, ^{90}Sr, and ^{106}Ru isotopes. Single and chronic treatments of organisms of various animals, and especially of the human organism are analyzed. A detailed analysis is made of the data on uptake and excretion of radioisotopes in milk and their transmission to progenies. Permissible doses of radioactive isotopes in the air, food and water are evaluated. Cumulative uptake of ^{137}Cs and ^{90}Sr by animals is discussed. 556 references are included. (R.V.J.)

Ecology

Refer also to abstracts 4576 and 5257.

4903 (CONF-671135-1) POSTATTACK INSECT PROBLEMS. Auerbach, S. I.; Crossley, D. A. Jr.; Shinn, A. F. (Oak Ridge National Lab., Tenn.). [1968]. 7p. Dep. CFSTI.

From Symposium on Postattack Recovery from Nuclear War, Fort Monroe, Va.

Because birds are important predators of insects and are more radiosensitive than insects, it is thought that insect plagues would be one of the major consequences of a nuclear attack. The significance of the beta-dose component of local fallout for small organisms is pointed out. The need for investigations on field response of insects subjected to acute or chronic beta exposures within their natural habitats is discussed. Comparative radiation profiles of a number of insect species are being investigated. The four life history stages of the house cricket, Acheta domesticus, were γ-irradiated with various doses. The survival times were similar for all stages. Studies on the mealworm, Tenebrio molitor, showed that survival times of larvae were much longer than those of pupae and adults exposed to the same doses. The need for long-term field experiments involving complete life cycles of several insects under a variety of radiation exposures is discussed. Since the production of many agricultural crops is dependent on the honeybee by virtue of its pollinating activities, combined laboratory and field investigations were conducted on the radiation response of honeybees. Hives of honeybees were γ-irradiated in the laboratory and returned to the field. The colonies were eliminated as functional units within 21 days. The importance of evaluating radiation effects from field experiments rather than from laboratory experiments is emphasized. (H.L.W.)

4904 APPLICATIONS IN LIFE SCIENCES. Gerrard, Martha (Oak Ridge National Lab., Tenn.). Isotop. Radiat. Technol., 6: 200-4(Winter 1968-69).

A review of the literature (32 references) on the labeling of small animals with radioisotopes for tracking purposes is presented. Methods of labeling the animals with radioactive tracers are described; the chief isotopes used for this purpose are ^{198}Au, ^{60}Co, ^{131}I, ^{124}Sb, and ^{182}Ta. Among small mammals studied by the radioisotope tracking procedure are bats, mice, moles, shrews, and voles. These are all animals whose movements have to be followed at night, beneath soil or litter, or behind walls. Other animals studied are birds, fish, frogs, snakes, and insects. Movements of the animals are followed by GM counters, scintillation counters, and other radiation detectors. (H.L.W.)

Genetics and Cytogenetics

Refer also to abstract 5030.

4905 TESTS FOR AN EFFECT OF THE Y-CHROMOSOME ON THE MUTAGENIC ACTION OF FORMALDEHYDE AND X RAYS IN DROSOPHILA MELANOGASTER. Ratnayake, Winston E. (Univ. of Ceylon, Peradeniya). Genet. Res., 12: 65-9 (Aug. 1968).

An additional Y-chromosome in either male or female Drosophila did not have an influence on the mutagenic action of formaldehyde-treated food. The lack of response of female germ cells to this treatment was not caused by a lack of a Y-chromosome, and the specific response of spermatocytes among germ cells was probably not caused by the striking activity of Y in these cells. In x-ray experiments, 1-day-old XY and XYY males were x irradiated with 4000 R and mated immediately to females for three to four days only. The results of the x-ray experiments with an unirradiated control are summarized. In two experiments, there was an increase of mutation frequency in XYY males, but it was not statistically significant. (BBB)

4906 SYSTEMATIC MICROSCOPIC STUDY OF THE ACTION OF RADIATIONS ON CULTURED ANIMAL CELLS. III. EMBRYONIC FIBROBLAST OF MICE RECEIVING γ-IRRADIATION EXAMINED WITH LIGHT MICROSCOPE. Bocquet, G.; Cappelaere, P.; Driessens, J. (Institut de Recherches sur le Cancer, Lille). Compt. Rend. Soc. Biol., 162: 461-5(1968). (In French).

Gamma irradiation of embryonic fibroblasts of mice in culture with doses between 150 and 2200 RADs causes immediate and occasionally permanent perturbations of the cellular division. Criteria are the classical aspects of mitotic inhibition, chromosome aberrations, and abnormal distribution of the mitotic stages. The irradiation also causes moderate alterations of the interphase nucleus which increases in volume, sometimes becomes irregular, and develops the appearance of cytoplasmic vacuoles. The post-irradiation behavior of the embryonic fibroblast of the mouse in interkaryokinesis is sharply opposed to that of the HeLa cell. (TSS) (tr-auth)

4907 STUDIES ON THE RADIOSENSITIVITY OF THE CHROMOSOMES IN THE CULTURED LEUKEMIC CELLS. Kang, Yung Sun; Ryu, Chung Hee (Seoul National Univ.). J. Nucl. Sci. (Seoul), 8: Pt. 2, 1-8(Aug. 1968).

The radiosensitivity of chromosomes in leukemic cells was examined and compared with that of normal peripheral leukocytes. In normal cells, the frequency of the modal chromosome number in control group was 98%, 94% for 40 R irradiated group, and 89% for 80 R group. The average rate of x-ray induced chromatid aberration was 0.0037 breaks/cell/R and the aberrations were all of the chromatid type. In leukemic cells the frequency of normal chromosome number of 46 in control group was 72%, 54% for 40 R group, and 47% for 80 R irradiated group. The rate of x-ray induced chromosome aberrations was 0.0070 on an average. Both the chromatid and the chromosome type aberrations were observed in the leukemic cells. (auth)

4908 X-RAY INDUCED CHROMOSOMAL ABERRATION OF ROOT-TIP CELLS IN RAPHANUS SATIVUS. Harn, Chang Yawl (Radiation Research Inst. in Agriculture, Seoul); Koh, Young Seu;

Chung, Duk Kyo; Chung, Dong Min. J. Nucl. Sci. (Seoul), 8: Pt. 2, 127-30(Aug. 1968). (In Korean).

Observations were made on chromosomal aberrations in root-tip cells in plants grown from x-irradiated dormant seeds of Raphanus sativus. Frequencies of single and paired bridges and acentric fragments at anaphase in somatic cells of root-tips were noted. With x-ray doses of 20, 40, 60, 80 and 100 kR respectively, percents of chromosomal aberration were 11.86, 17.42, 31.67, 41.69 and 48.59. The acentric fragments at anaphase are very low in frequency compared with single and paired bridges; bridges without any fragments were also observed. (auth)

4909 SOYBEAN IMPROVEMENT BY APPLICATION OF X-RAY AND THERMAL NEUTRON IN KOREA. Harn, Chang Yawl; Kwon, Shin Han; Kim, Chi Moon; Lim, Kun Hyuk (Radiation Research Inst. in Agriculture, Seoul). J. Nucl. Sci. (Seoul), 8: Pt. 2, 131-8(Aug. 1968). (In Korean).

Two leading varieties, Kum Kang Dai Rip and Chung Buk Baik, were chosen and continuous selections and eliminations were made throughout the R_1, R_2, R_3, R_4, and R_5 generations. The results obtained were summarized as follows. Seven early maturing mutants were selected from x-irradiated Kum Kang Dai Rip populations. Important agronomic characteristics i.e., yield, plant height, seed size, were not significantly affected except earliness. The line, KEX-2, out of the seven selected lines, was observed to mature on the average of 13 days earlier in R_3, R_4, and R_5 generation tests. In thermal neutron irradiated Kum Kang Dai Rip and Chung Buk Baik varieties large seeded mutants were selected from the R_2 populations. No statistically significant difference was found for seed size in tests of R_3 and R_4 generations in variety Chung Buk Baik, whereas highly significant increases in seed size were observed for variety Kum Kan Dai Rip. Among the large seeded selections in Kum Kang Dai Rip, two lines, KL-10 and KL-20, showed statistically significant increases in seed yield. The percentage of shattering of the shattering resistant selections from thermal neutron irradiated second generation in Chung Buk Baik was considerably decreased in tests of R_3 and R_4 generations. A selected line, S 15-15, at R_3 population showed significant decrease in shattering habit (18.3) in the test of R_4 generation. (auth)

4910 STUDIES ON THE INDUCTION OF MUTATIONS BY MEANS OF RADIATIONS AND CHEMICALS. I. THE EFFECTS OF X-RAY AND ETHYL METHANESULPHONATE ON BARLEY. Harn, C. Y.; Kim, C. M.; Im, K. H.; Kim, Y. S. (Radiation Research Inst. in Agriculture, Seoul). J. Nucl. Sci. (Seoul), 8: Pt. 2, 139-46(Aug. 1968). (In Korean).

The barley seeds of two leading varieties, Suwon No. 18 and Chilbo, in the central region of Korea were treated with x-ray or EMS. The morphological and histological characteristics of M_1 plants obtained, are as follows: Significant differences in both germination and survival rate of M_1 plants were observed between x-ray and EMS treated seeds, the response to the x-ray being more pronounced. Height of M_1 plants is shortened and heading time is delayed, apparently, owing to the damage incurred to the plants by high dosages of x-ray and also high concentrations of EMS. Reduction of M_1 fertility shows linear response to either dosage or concentration of the mutagens, while the frequency of sterile plants does not. The frequency of striata type, a chlorophyll mutant, in the EMS treated plants, was higher than those x-rayed. (auth)

4911 PLANT BREEDING. A Symposium held at Iowa State University, March 1-5, 1965. Frey, Kenneth J. (ed.). Ames, Iowa, Iowa State University Press, 1967. 439p. (CONF-650333).

A separate abstract was prepared for one chapter of the symposium. The eleven chapters of the book are concerned with the relative significance of research in biosystematics, cytogenetics, pest resistance, and physiology for plant breeding. Past, present, and future contributions of research to plant breeding are evaluated. The importance of research in plant breeding for world agricultural production is emphasized. A subject index is included. (H.L.W.)

For an abstract of the individual paper see: 4912.

4912 MUTATION BREEDING. Gregory, W. C. (North Carolina State Univ., Raleigh). Contracts AT(40-1)-265; AT-(40-1)-1747. pp 189-218 of Plant Breeding. Frey, Kenneth J. (ed.). Ames, Iowa, Iowa State University Press, 1967.

From Conference on Plant Breeding, Ames, Iowa. See CONF-650333.

A review of recent work on radioinduced mutations in various plants is presented. The fitness character of peanuts was increased x-radioinduced mutations; mutations induced by thermal neutrons and x radiation increased the fitness character of Triticum vulgare. Early and late flowering strains were produced in Arabidopsis by radiation. Mutations which conditioned lodging resistance in oats, barley, rice, and wheat were induced by x rays, beta rays, fast and slow neutrons. Data from the work with peanuts are used to derive mathematical relationships between the numbers of plus and minus mutations in the polygene system. Graphs and tables are presented to show frequency distributions of progeny mean yields of various mutants and relations between magnitude of change and frequency of mutants. It was concluded that the hypothesis for natural variation also fits that for artificially induced variation. (H.L.W.)

4913 GENETIC EFFECTS OF IONIZING RADIATIONS AND THE AMELIORATION OF PLANTS. Pereau-Leroy, P. Sci. Progr.-Nature, No. 3401, 321-6(Sept. 1968). (In French).

The possibility of using ionizing radiation to improve plants is examined briefly. Plants reproducing by both sexual and vegetative means are considered. Results obtained with the γ radioinduced mutations of carnations are summarized. (J.S.R.)

4914 HIGH ALKALINE PROTEASE YIELDING MUTANTS OF ASPERGILLUS NIGER INDUCED BY ULTRAVIOLET IRRADIATION. Matsushima, Kinichi; Shimada, Kyo (Mie Univ., Japan). Mie Daigaku Nogakubu Gakujutsu Hokoku, No. 36, 63-7 (Dec. 1967). (In Japanese).

Two strains of alkaline protease-producing mutants of Aspergillus niger, that were derived by uv irradiation, were studied morphologically as well as physiologically. Morphologically, both mutants varied considerably from the parent. They produced white conidia and their conidial walls were smooth or nearly so. Conidial heads and vesicles of the mutants were much smaller than those of the parent. Physiologically, the mutants differed from the parent in growing on urea- and $NaNO_2$ medium vigorously and growing on inulin medium poorly. The content of enzymes of the mutants also varied from the parent. The mutants were superior to the parent in amylolytic activities and inferior in cellulolytic activities. The mutants differed from each other in the character of the colonies on Czapek solution-agar. Surface of the colony of Mutant 8 appeared to be mealy, typically furrowed in a radial pattern, and the reverse side of the colony was grayish olive green. The colony of Mutant 29 was velvety or slightly floccose with shallow radial furrows, and reverse side of the colony was yellow. (NSA of Japan)

4915 RADIOBIOLOGICAL DAMAGE: A NEW CLASS IDENTIFIED IN BARLEY SEEDS STORED AFTER IRRADIATION. Conger, B. V.; Nilan, R. A; Konzak, C. F. (Washington State Univ., Pullman). Science, 162: 1142-3(Dec. 6, 1968).

A new class of radiobiological damage has been identified in ^{60}Co γ irradiated barley seeds. Consisting of both physiological and genetic damage, it appears to be independent of oxygen and long-lived free radicals, and develops very slowly during storage after irradiation. Increasing the storage temperature accelerates its development. (auth)

4916 X-RAY-INDUCED SINGLE-STRAND BREAKS AND JOINING OF BROKEN STRANDS IN SUPERINFECTING λ DNA IN ESCHERICHIA COLI LYSOGENIC FOR λ. Boyce, Richard P.; Tepper, Marcos (Yale Univ., New Haven). Virology, 34: 344-51(Feb. 1968).

Experiments were performed on the rate of induction of single-strand breaks in covalent circular λ DNA by x rays and strand rejoining upon subsequent incubation of the irradiated superinfected bacteria. In view of the enhancement of x-ray effects by oxygen, the yield in cells irradiated either in the presence of oxygen or in its absence was also studied. The results showed that covalent circular DNA was converted to notched circular DNA as an exponential function of x-ray dose with an 1/e dose of 22 krad in the presence of oxygen and 62 krad in the presence of nitrogen. The notched circular DNA in irradiated superinfected cells rapidly reverted to covalent circular DNA during incubation at 37°. The formation of covalent circular DNA after x-irradiation occurred normally in all radiation-sensitive mutants tested, including those deficient in recombination. (BBB)

4917 CHLOROPHYLL-DEFICIENT MUTANTS IN TOMATO REQUIRING VITAMIN B_1. II. ABNORMALITIES IN CHLOROPLAST ULTRASTRUCTURE. Boynton, John E. (Univ. of California, Davis). Hereditas, 56: 238-54(1966).

In 2 x-ray-induced tomato mutants (ten and spa) and 1 spontaneous mutant (tl), all deficient of chlorophyll and requiring thiamine, chloroplasts were examined by electron microscopy. Chloroplasts of yellowish-green leaf tissue of spa and tl at the early stages of bleaching and those of more or less stable yellowish tissue of ten had a normal number of grana per plastid but showed a high percentage of grana with diffuse substructure, resulting from a breakdown of the grana. Grana in subsequently de-

veloped whitish bleached leaf tissue of tl and spa were drastically reduced in number per plastid, became abnormally large in dia, and included higher percentages with diffuse substructure. Plastids containing only primary lamellar layers and no grana were frequently observed. Lamellar degeneration was cyclic, the grana regeneration diminishing as the thiamine supply of the tissue decreased. Thiamine treatment of tl and spa corrected the metabolic chaos created by the genetically conditioned shortage of the vital enzyme cofactor. Chloroplasts developed normally, forming a stable lipoprotein grana-fretwork system; the chlorophyll pigments remained light-stable, and the mutant plants assumed a phenotype indistinguishable from normal. The partial therapeutic effect of thiamine on the ten mutant was also manifested at the level of chloroplast ultrastructure. (BBB)

4918 LINKAGE STUDIES IN PISUM. VII. THE MANIFESTATION OF THE GENES CRI AND COCH AND THE DOUBLE RECESSIVE IN PISUM. Blixt, Stig (Plant Breeding Inst., Weibullsohlm, Sweden). Agri Hort. Genet., 25: 121-44(1967).

Some radioinduced mutants of peas were studied. The mutation crispa is determined by recessivity in a single gene, located in chromosome V, and the gene is given the symbol cri. The crispa type is characterized by crisp or folded leaves and stipules, with elongated leaflets tending to be obovate. The crisp structure was found to be due to foldings or outgrowths in the tissues. The cochleata mutant was found in material treated with neutrons. The main characteristics are an elliptical lamina with a petiole, reaching sometimes the same length as the lamina. The mutant was given the gene symbol coch. Linkage was found with R and Tl in chromosome VII. Crossing some of the crispa mutants was performed to establish the gene(s) involved; also, a cross crispa X cochleata was carried out. The resulting double-recessive showed many interesting morphological details, and a description of the cri coch genotype is reported together with the results of the crosses. The mutant crispa$_{R2}$, line 5125 induced by 5-krad doses of x rays in Weitor variety and crispa$_{R3}$, line 5144, induced by 8-krad doses of x rays in Weitor, were crossed to line 5080 and with each other. The result showed that for all 3 lines the same gene was involved, viz. cri in chromosome V. The cochleata mutant line 5138, induced by ethyleneimine in Weitor, was crossed to the crispa lines. As expected, no linkage was found between cri and coch. The cri coch plants showed morphological traits not present in either parent, such as the elongation of the petiole, and the almost complete disappearance of the stipules. The backgrounds are discussed. (BBB)

4919 EFFECT OF GAMMA-RAY IRRADIATION ON PROTEIN CONTENT OF SORGHUM. Dabholkar, A. R. (Maize Research Station, Chhindwara, India). Sci. Cult. (Calcutta), 34: 184-5(Apr. 1968).

Seed of two varieties of sorghum were x irradiated at a dose of 10, 15, or 20 krad. This resulted in a decrease in the protein content of grain of the first generation and an increase in the protein of the second generation in comparison with controls. (C.O.)

4920 STUDIES ON THE GARLIC BREEDING USING RADIATION. I. CYTOLOGICAL EFFECTS ON GAMMA-RAY INDUCED R_1 GENERATION IN GARLIC ALLIUM SATIVUM. Harn, Chang Yawl; Choi, Kyu Jin; Koh, Young Seu (Radiation Research Inst. in Agriculture, Seoul). J. Nucl. Sci. (Seoul), 8: Pt. 2, 115-19 (Aug. 1968). (In Korean).

Present observations are carried out on chromosomal aberrations in root-tip cells of Korean garlic Allium sativum exposed to gamma-rays from ^{60}Co. The results of observation were based on the frequency of dicentric chromosomes and acentric fragments. As the gamma-ray doses increase, the frequency of chromosomal aberration increases gradually. The presence of chromosome fragments is more frequently observed than chromatid fragments or dicentric chromosomes; coagulated chromosomes were also found. (auth)

4921 INTERACTION OF THE EXR AND LON GENES IN ESCHERICHIA COLI. Donch, John; Green, Michael H. L.; Greenberg, Joseph (Medical Research Foundation, Palo Alto, Calif.). J. Bacteriol., 96: 1704-10(Nov. 1968).

Strains of Escherichia coli carrying the gene lon typically produced excess capsular polysaccharide, and were sensitive to ultraviolet light irradiation, thymine starvation, and nalidixic acid, forming long filaments after these treatments. Sensitivity was reduced by a number of posttreatments. In the presence of a second uv sensitivity gene, exr, some of these properties were suppressed: long filaments were not formed, the effect of lon on uv and nalidixic acid sensitivity was greatly reduced, and irradiation posttreatments gave an enhancement of survival characteristic of exr rather than lon strains. Production of capsular polysaccharide was not affected by the exr gene. (auth)

4922 EFFECTS OF TEMPERATURE SHOCKS ON THE INITIAL RADIOINDUCED DAMAGE TO CHROMOSOMES IN DORMANT SEEDS. Atayan, R. R. (Armenian Agriculture Inst., Erevan). Dokl. Akad. Nauk Arm. SSR, 46: No. 1, 22-5(1968). (In Russian).

Effects of high-temperature shock on the yield of chromosome aberrations in dormant seeds irradiated before and after the shock were studied with pea seeds (Kapital) containing 17% water and x-irradiated with 300 to 500 R per minute. Tabulated data are given on the effects of temperature shocks on the number of fragments in initially damaged cells and on the cell restoration during irradiation with 10 and 30 kR. Data obtained showed that temperature shocks as an additional factor to irradiation influenced the final yield of radioinduced chromosome aberrations. They do not influence the initial radiosensitivity but significantly affect restorative processes. (R.V.J.)

4923 ULTRAVIOLET LIGHT INDUCED MUTATION IN EXTRACTED DNA. Scheltgen, Elmer. Houston, Tex., Univ. of Texas, 1968. 65p.

Thesis.

Uv irradiation of extracted DNA was shown to increase frequency of adenine revertants when analyzed by transformation in B. subtilis strain Mu8u5u6-S. Statistically, results were significant at the 93% level. An increase in the temperature during transforming DNA uptake and incorporation caused both a decrease in the transformation frequency and a decrease in the transforming activity of irradiated DNA relative to nonirradiated DNA. Attempts were made to induce auxotrophic mutations by uv light in extracted native and denatured DNA without success. Uv irradiation of DNA at 100°C followed by slow cooling was found to produce a marked increase in the number of adenine reversions in DNA as detected by transformation of the adenine⁻ B. subtilis strain Mu8u5u6-S cells to prototrophy. The result may be due either to the uptake of the irradiated DNA and its incorporation into the host genome or to the uptake of the irradiated DNA, its subsequent degradation and the incorporation of the breakdown products into newly synthesized DNA. (Disser. Abstr.)

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Refer also to abstracts 4578, 4744, 4746–4748, 4763, 4786, 4797, 4803, 4804, 4828, 4837, 4881, 4890, and 5449.

4924 (AEC-tr-6964) ASSESSMENT OF THE STATE OF HEALTH AND PRINCIPLES OF PLACEMENT FOR PERSONS SUBJECTED TO THE ACTION OF IONIZING RADIATION. Gus'kova, A. K.; Baysogolov, G. D. Translated from Med. Radiol., 13: No. 5, 3-9(May 1968). 8p. Dep. CFSTI.

Data are presented for use by physicians for evaluation of the state of health of persons exposed to ionizing radiations because of their occupation. (B.G.D.)

4925 (AEC-tr-6967) ^{233}Pa, "SIMULATOR OF PLUTONIUM," FOR DIRECT ESTIMATION OF PULMONARY CONTAMINATION. Boulay, Pierre; Chivot, Jean-Jacques; Jeanmaire, Lucien; Lansiart, Alain. Translated by A. A. Horvath for Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex., from Compt. Rend., Ser. D, 265: 1571-4 (Nov. 13, 1967). 6p. Dep. CFSTI.

Protactinium-233 possesses simultaneously x rays of low penetration capacity, of an energy value close to the one of plutonium-239, as well as gamma-rays, which, on the other hand, pass readily several centimeters of tissue. These properties, as well as the radioactive period of protactinium, seem to be favorable characteristics for its utilization for in situ measurement of pulmonary contamination by plutonium. (auth)

4926 (BNWL-SA-2109) ELECTROMAGNETIC SPECTRUM: IONIZING RADIATION, SOURCES OF EXPOSURE. Fisher, W. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 19, 1968. 7p. (CONF-680930-2). Dep. CFSTI.

From Electromagnetic Spectrum Conference, Richland, Wash.

A general discussion of radiation sources of exposure to both laboratory personnel and large populations is presented. It is pointed out that education of the user is essential for preventing radiation sources from being radiation exposures to man. (W.H.K.)

4927 (HASL-200) FALLOUT PROGRAM. Quarterly Summary Report, June 1–September 1, 1968. Hardy, Edward P. Jr.; Rivera, Joseph (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Oct. 1, 1968. 85p. Dep. CFSTI.

Current data from the HASL Fallout Program, the National Radiation Laboratory in New Zealand, the Euratom Joint Nuclear Research Center at Ispra, Italy, the Division of Biological and

Medical Research at Argonne National Laboratory, and the Department of Animal Science at Colorado State University are presented. The initial section consists of interpretive reports and notes covering the following topics: concentration of ^{95}Zr–^{95}Nb and ^{137}Cs in bovine rumen contents; world wide deposition of ^{90}Sr through 1967; interlaboratory comparisons of ^{90}Sr in seawater measurements; strontium fission product ratios in monthly fallout; and intake of ^{90}Sr, stable strontium and calcium by infants. Subsequent sections include tabulations of radionuclide levels in surface air, fallout, milk, other diet components and tap water. A bibliography of recent publications related to radionuclide studies is also presented. (auth)

4928 (KURRI-TR-4) A PRELIMINARY NOTE ON THE RADIOACTIVE DUSTS IN LABORATORIES. Tsujimoto, Tadasi; Negoro, Akihiko; Sumino, Teruie (Kyoto Univ. (Japan). Research Reactor Inst.). June 4, 1965. 24p. (In Japanese and English). Dep.

The accidental release of the clouds of radioactive substances from hot areas could not be definitely estimated without the full informations on the radioactive background of dusts distributed in the laboratories. The relation between the daily variation of radioactive background in laboratories and field is examined by gross counting of α ray and β ray + γ ray and γ ray spectroscopy and examination of dusts adhering to the filter in the dust sampler. It is found that the radioactive background in the laboratories shows daily variation and is influenced by the variation of radioactivity in the field. Under the reactor operation, the γ ray spectroscopy of the dusts in laboratories shows a certain peak which is not found in the measurement of the background. (auth)

4929 (NP-17515) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 6, Number 4. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). Apr. 1968. 29p. Dep.

A study of radiation exposure doses from film monitoring service data of 1964 and 1965 is reported. Fallout monitoring in air, precipitation, and milk for March 1968, along with reactor environment monitoring for the same period are presented. (M.C.G.)

4930 (NP-tr-1703) RADIOLOGICAL PROTECTION PROBLEMS OF TRITIUM. Dietrich, E.; Koenig, L. A. Translated by E. M. Gillis (Atomic Energy Research Establishment, Harwell, Eng.), from Atompraxis, 13: 454-7(1967). 13p. Dep.

The properties of tritium that are important in radiological protection are described. The hazards from tritium are internal since it emits very low energy beta particles. Tritium can enter the body via the lungs, the skin, and the intestinal tract. Most frequently tritium is taken in as water or water vapor. Radiological protection measurement problems are described and the most common methods of solving them are discussed. Protection factors relative to tritium-containing water vapor are examined. The techniques used at the Karlsruhe research reactor for tritium control are summarized. (B.G.D.)

4931 (NSJ-tr-136) AN APPLICATION OF ULTRA HIGH SPEED α-AUTORADIOGRAPHY IN THE DETECTION OF ^{239}Pu SKIN SURFACE CONTAMINATION. Matsuoka, Osamu; Yoshikawa, Kikuo; Fukumoto, Takeo. Translated from Hoken Butsuri, 2: 121-7(Sept. 1967). 11p. Dep.

High Speed α-Radioautographic technique, which was developed by Hsieh et al., was applied to the detection of ^{239}Pu skin contamination to obtain an accurate information as to the contaminated area around the wound. Silver-activated zinc sulfide is used as an intensifier in combination with high speed Polaroid film. The intensifier film mounted on the double aluminum coated Lumiler film is interposed between skin and photographic film. All procedure of above autographic technique was applicable without dark room in routine using special light-tight attachment. About 100 dpm ^{239}Pu contamination of skin can expose the shape of contaminated area by several minutes contact by this method. (auth)

4932 (SWRHL-3-r) FINAL REPORT OF OFF-SITE SURVEILLANCE FOR OPERATION DOMINIC II. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). July 15, 1965. 51p. Dep. CFSTI.

Operation Dominic II was a series of four nuclear tests conducted on the Nevada Test Site between July 7 and 17, 1962. This report concerns the program of off-site radiological surveillance conducted throughout Operation Dominic II by the U. S. Public Health Service (PHS) for the Atomic Energy Commission (AEC) in accordance with a Memorandum of Understanding between the two agencies. The field and laboratory methods and equipment used, the measurements made, and the results obtained from off-site surveillance of the four events are described. No cases of alleged radiation sickness or injury to people, livestock, or property developed during the operation. The results of surveillance presented in this report indicate that the safety criteria established by the AEC for the off-site population were not exceeded during Operation Dominic II. (auth)

4933 (SWRHL-4-r) FINAL REPORT OF OFF-SITE SURVEILLANCE FOR OPERATION STORAX. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). July 20, 1965. 63p. Dep. CFSTI.

The methods used and the results obtained from off-site surveillance conducted during Operation Storax, July 1, 1962 to June 30, 1963, by the Southwestern Radiological Health Laboratory, Las Vegas, Nevada for the Atomic Energy Commission (AEC) are described. Analysis of the results obtained from various environmental sampling programs indicates that the safety criteria established by the AEC for the off-site population were not exceeded as a result of any one or combination of events of Operation Storax. (auth)

4934 (SWRHL-7-r) FINAL REPORT OF OFF-SITE SURVEILLANCE FOR THE KIWI B4D EXPERIMENT. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). July 23, 1964. 22p. Dep. CFSTI.

The Public Health Service provided off-site surveillance in support of the KIWI B4D reactor tests conducted on May 8 and May 13, 1964. This support consisted of tracking the effluent, monitoring radiation dosage to the off-site population, and collecting environmental samples (air, milk, and water). The data collected indicate that no hazard to the off-site population was created as a result of the KIWI tests. (auth)

4935 (SWRHL-15-r) FINAL REPORT OF OFF-SITE SURVEILLANCE FOR THE KIWI B4E EXPERIMENT. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Jan. 25, 1965. 26p. Dep. CFSTI.

The Public Health Service provided off-site surveillance for the KIWI B4E full power reactor run conducted on August 28, 1964, and for a restart of the reactor on September 10, 1964. Small amounts of radioactive material were detected off site following both tests; however, in no instance did exposures exceed the radiological safety guides set forth in the AEC Manual, Chapter 0524. (auth)

4936 (SWRHL-16-r) FINAL REPORT OF OFF-SITE SURVEILLANCE FOR THE NRX-A2 EXPERIMENT. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Feb. 3, 1965. 24p. Dep. CFSTI.

The Public Health Service provided off-site surveillance in support of the NRX-A2 reactor tests conducted on September 24 and October 15, 1964. This support consisted of tracking the effluent, monitoring radiation dosage to the off-site population, and collecting environmental samples (air, milk, water and vegetation). Analyses of these data indicate that no hazard was created to the off-site population from the NRX-A2 tests. (auth)

4937 (SWRHL-17-r) FINAL REPORT OF OFF-SITE SURVEILLANCE FOR THE KIWI TNT EXPERIMENT. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Aug. 6, 1965. 24p. Dep. CFSTI.

The Southwestern Radiological Health Laboratory provided off-site radiation surveillance in support of the Kiwi Transient Nuclear Test (TNT) conducted on January 12, 1965. This support consisted of tracking the effluent, monitoring radiation dosage to the off-site population and collecting environmental samples in southern Nevada and California. Although off-site contamination occurred as a result of Kiwi TNT, the data collected indicate that radioactivity levels did not exceed Radiation Protection Guides established by the Atomic Energy Commission for the off-site population. (auth)

4938 (SWRHL-18-r) FINAL REPORT OF OFF-SITE SURVEILLANCE FOR THE NRX-A3 EXPERIMENT. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Oct. 8, 1965. 31p. Dep. CFSTI.

The Southwestern Radiological Health Laboratory provided off-site radiation surveillance in support of the NRX-A3 experiments of April 23, May 20, and May 28, 1965. This support consisted of tracking the effluent, monitoring radiation dosage to the off-site population and collecting environmental samples in downwind areas. Although off-site contamination occurred as a result of the NRX-A3 tests, the data collected indicate that radioactivity levels did not exceed the safety criteria established by the Atomic Energy Commission for the off-site population. (auth)

4939 (SWRHL-19-r) FINAL REPORT OF OFF-SITE SURVEILLANCE FOR THE PHOEBUS 1-A EXPERIMENT. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Jan. 17, 1966. 24p. Dep. CFSTI.

The Southwestern Radiological Health Laboratory provided off-site radiation surveillance in support of the Phoebus 1-A Experiment of June 25, 1965. This support consisted of tracking the effluent, monitoring radiation dosage to the off-site population and collecting environmental samples in downwind areas. Although off-site contamination occurred as a result of the Phoebus test, the data collected indicate that radioactivity levels did not exceed the safety criteria established by the Atomic Energy Commission for the off-site population. (auth)

4940 RADIATION-PROTECTIVE GARMENT WITH FORCED AIR VENTILATION. Phipps, Clifford G. (to Secretary of the Navy). U. S. Patent 3,394,260. July 23, 1968. Filed Oct. 22, 1965.

A radioprotective garment is described and illustrated that is to be worn by an individual undergoing bio-medical testing, during which time the reception by such individual of either ambient electrostatic and/or electromagnetic energy may produce physiological effects capable of introducing inaccuracies into the test data obtained. The garment is a laminated assembly of at least two electrically conductive layers insulated from one another, one layer being grounded and the other being of comminuted metal effective as a shield below audio frequency. Pressurized air is introduced into the garment to maintain even body temperature and reduce excessive perspiration. (auth)

4941 POSSIBILITIES OF ACQUIRING RAPIDLY A SURVEY OF FOOD CONTAMINATION. Knoop, E. (Bundesforschungsanstalt fuer Milchwirtschaft, Kiel). Landwirt. Forsch., No. 19, 1-11(1965). (In German).

The determination of the β emitter content in foods requires a tedious chemical separation and a many-day wait for radiochemical equilibrium. The activity of γ emitters can be measured in a short time without preliminary separation and waiting. The possibility of establishing a relation between the activity of a β emitter and that of a γ emitter in a food was studied. The ratio of the ^{137}Cs activity to the ^{90}Sr activity in milk have been reported. These measurements showed that there was not only a rigid relation between the heights of these activity ratios in the milk and that of the earth surface with the fallout, but that there are, for the various areas of the German Federal Republic, different but known relations that are valid. The ratio of the ^{137}Cs activity to the ^{90}Sr activity in milk depends on the age of the fallout in the same manner as precipitation. It was therefore proposed that in the atmosphere there is a separation, that the Cs falls to the earth faster than the Sr. It is possible therefore to obtain in a brief time an adequate survey on the content in β and γ emitters from the γ spectrometric determination of radionuclides in milk and other foods. (TSS) (tr-auth)

4942 PROTECTION OF SPACE TRAVELLERS. Repules, No. 12, 9(1967). (In Hungarian).

In view of the interest in using magnetic shielding from corpuscular radiation in space, Soviet researchers conducted experiments on the biological effects of magnetic fields. Exposure of mice to a magnetic field of 14,000 oersted for two weeks resulted in a white cell reduction of 28%; while an exposure to only 8500 oersted resulted in a 30% increase in the red blood cells and a 14% increase in hemoglobin content. Exposure of chlorella to a magnetic field of 20,000 oersted resulted in an acceleration of their development. Exposure of bacteria to forces of 140,000 oersted had no evident effect on their development or mutability; such an exposure resulted in a slowdown of cell division in fertilized sea urchin ova. Exposure of anthropoid apes to magnetic fields of 70,000 oersted caused considerable changes in the EEG and reduction in their heart rate by 25%. (auth)

4943 CALCULATION OF DOSE DISTRIBUTION OF ^{60}Co TELETHERAPY WITH A DIGITAL COMPUTER. II. APPLICATIONS FOR COPLANAR RADIATION METHODS. Fehrentz, Dieter; Kuttig, Helmut; Braun, Gerhilt (Univ., Heidelberg. Deutsche Krebsforschungszentrums, Heidelberg). Strahlentherapie, 136: 279-88(Sept. 1968). (In German).

A computer program was used for calculation of dose distribution for ^{60}Co γ teletherapy. Some examples of dose distributions for coplanar irradiation are demonstrated. (auth) (TSS)

4944 RADIOACTIVITY IN FOOD. Goded y Mur, A. An. Lactol. Quim. Agr. Zaragoza, 13: 3-7(1966). (In Spanish).

The contamination of food by ^{90}Sr as a result of nuclear explosions is discussed. The path of ^{90}Sr from the atmosphere to the bones of man is illustrated. The ^{90}Sr content in the normal diet of the individual is discussed. The pattern of the ^{90}Sr content in wheat, milk, soil, and water since 1956 is briefly outlined. Methods to eliminate radiostrontium from milk are indicated. (J.S.R.)

4945 RETENTION OF THE FISSION PRODUCT, ^{137}Cs, IN DOMESTIC SPECIES OF FUNGI. Grueter, H. (Univ., Muenster, Ger.). Z. Lebensm.-Untersuch. Forsch., 134: 173-9(1967). (In German).

Investigations on the artificial radioactivity of vegetation as a result of nuclear bomb tests gave an unusually high concentration of the fission product ^{137}Cs in various fungi. Although several fission products were present in the soil, except for ^{137}Cs and a small amount of ^{90}Sr, no other artificial radioisotopes were taken up in the mineral content of the fungi. In contrast with K, which constitutes the greatest part of the inorganic fungi constituents, ^{137}Cs was preferentially enriched by more than an order of magnitude in comparison with the ^{137}Cs concentration in the soil. The nature of the soil has a very strong effect on the ^{137}Cs content of the fungi: pine needle soil showed the highest value, deciduous forest soil was much less, and meadows, in general, had no detectable fission product activity. In a cooking study with Krempling (Paxillus involutus) 64% of the ^{137}Cs activity was transferred to the cooking water. A significant contribution to the radiation burden of man is not likely because of the relatively low value of fungi as a food. (tr-auth)

4946 EVALUATION OF LASER HAZARDS. Sliney, David H.; Palmisano, William A. (Army Environmental Hygiene Agency, Edgewood Arsenal, Md.). Amer. Ind. Hyg. Ass. J., 29: 425-31 (Sept.-Oct. 1968).

Recent developments in laser technology have produced greater energy and power outputs in an ever-increasing variety of lasers of differing wavelengths. A variety of hazards exist to individuals working at or in the vicinity of laser operations. A program of hazard evaluation and control has been conducted by the authors in a variety of laser installations. The principal hazards of laser radiation to the eye due to both direct and reflected viewing are discussed. Criteria are given for determining the hazards of a given laser by evaluating the effects of the laser output characteristics (power or energy output, wavelength, emergent beam diameter and divergence) and the effects of various environmental factors (output or laboratory setting, ambient lighting, etc.). Methods of measuring or calculating the light intensity at a given point and guidelines for control of hazards are given. (auth)

4947 MILK AND FOOD. Radiol. Health Data Rep., 8: 577-99(Oct. 1967).

Data from selected national, international, and state milk and food surveillance activities are presented. An effort was made to present a cross-section of routine sampling programs which may be considered of a continuing nature. Routine milk sampling was defined as one or more samples collected per month. Data from the Public Health Service Pasteurized Milk Network for 1966 and January to June 1967, Canadian Milk Network for June, 1967, and Pan American Milk Sampling Program for June, 1967 are presented. Data concerning radionuclides in institutional diet samples for 1966 and January to March, 1967 are also reported. (D.H.M.)

4948 ISOTOPE TECHNOLOGY DEVELOPMENT. Contracts 12-14-100-7187(74); AT(04-3)-536. Isotop. Radiat. Technol., 6: 146-53(Winter 1968-69).

Spinach, peas, and broccoli were sprayed with a sufficient amount of very dilute solutions of ^{89}Sr or ^{134}Cs, to provide ~1 μc per crop container. Dwarf pear and peach trees were sprayed with slightly stronger solutions to give 4 to 6 μc per tree. Both fruits and vegetables were grown in soil treated with 15 μc of radionuclide for each 40 lb of soil. External contamination was readily washed from fruits and vegetables picked 1 or 2 hr after treatment. Internal contamination could be reduced greatly by ordinary food-preparation processes, except for strawberries. (auth)

4949 SPECIFICATION FOR RADIOLUMINOUS TIME MEASUREMENT INSTRUMENTS. PART I. INSTRUMENTS BEARING RADIOACTIVE LUMINOUS MATERIALS. BS 4333, 1968. London, British Standards Institution, 1968. 9p. 6s.

Requirements for instruments having hands and/or dials bearing radioactive luminous substances are specified, including radionuclides and levels of radioactivity permissible, both with regard to instruments for use by the general public and those having a higher degree of luminosity for special purposes. Tests for adhesion of the luminous compounds are also laid down. A marking system for special time indicators is described. The radionuclides permissible are tritium and ^{147}Pm, together with ^{226}Ra under suitable precautions. (UK)

4950 INFLUENCE OF A TENSIOACTIVE SUBSTANCE ON THE BEHAVIOR OF RADIOACTIVE WATER IN AN ARTIFICIAL EARTH. Morette, A.; Divin, J.-P. Eau, 55: 221-4(May 1968). (In French).

In the absence of surfactant (Na dodecylbenzenesulfonate) radio-

strontium is fixed in the absence of mineralization or CO_2; if CO_2 is present, the Sr is rapidly eluted. If Ca(II) ions are present in the water, Sr is even more strongly eluted. When the surfactant is added to CO_2-containing waters, the Sr is not so strongly eluted. This is related to the diminution of the activity of dissolved gases by surfactants. Water of low mineral content, however, removes Sr from the earth samples to a greater extent when surfactant is present. The cause of this is related to the deposition of an adsorbed layer of surfactant on the mineral, displacing adsorbed Sr. This study is extrapolated to consideration of radioactive pollution. It serves to point to the multiple causes affecting each pollution problem. Data are graphed for deionized water, Paris water, and water with added $MgSO_4$ and $CaCl_2$. (BBB)

4951 BIOLOGICAL HALF-LIFE OF ^{75}Se-SELENOMETHIONINE IN MAN. **Ben-Porath, Moshe; Case, Lawrence; Kaplan, Ervin (Veterans Administration Hospital, Hines, Ill. Loyola Univ., Chicago). J. Nucl. Med., 9: 168-9(Apr. 1968).**

The biological half-life of ^{75}Se-selenomethionine was determined for healthy subjects and for patients suffering from malignant lymphomas. The data on normal subjects were used to calculate the whole-body irradiation dose ($\beta + \gamma$) for a 250 μCi tracer dose of ^{75}Se-selenomethionine as 1.63 rad. (C.H.)

4952 RADIATION CONTROL FOR HEALTH AND SAFETY ACT OF 1967. HEARINGS BEFORE THE COMMITTEE ON COMMERCE, UNITED STATES SENATE, NINETIETH CONGRESS, FIRST SESSION ON S. 2067, TO PROVIDE FOR THE PROTECTION OF THE PUBLIC HEALTH FROM RADIATION EMISSION FROM ELECTRONIC PRODUCTS WHICH ARE IN COMMERCE OR ARE IMPORTED INTO THE UNITED STATES, AUGUST 28, 29, AND 30, 1967. SERIAL NO. 90-49. Washington, D. C., Joint Committee on Atomic Energy, 1968. 412p. GPO

A report on the hearings on S. 2067 which will provide control of radiation hazards that may be associated with a growing number of devices in industry, in medicine and dentistry, in communications, and in the home is presented. The report includes opening remarks and introduction of S. 2067, a chronological list of witnesses, and information submitted for the record. Two appendixes are included which list communications on the effects of radiation and steps which can be taken on reducing the risk of hazards present. (B.G.D.)

4953 COSMIC RADIATION AND THE CONCORDE. **Hepburn, A. N. (Air Corporations Joint Medical Service, London). Ann. Occup. Hyg., 11: 341-6(Oct. 1968).**

One of the environmental problems associated with high performance supersonic transport aircraft is the exposure of crew and passengers to increased amounts of cosmic radiation, comprising radiations from both galactic and solar sources. As part of the Concorde programme, galactic radiation was measured in commercial subsonic aircraft and in balloons. From these results it is not considered that there will be any risk from exposure to galactic radiation. The problem of intermittent exposure to higher levels from solar activity is outlined, and airborne detection equipment is described, together with suggested ranges for the instrument. (auth) (UK)

4954 TISSUE ABSORPTION THEORY APPLIED TO FORMULATION OF RADIOGRAPHIC TECHNIQUE RESULTING IN TISSUE AS THE VARIABLE FACTOR. **McDaniel, Clarence Thomas (York General Hospital, Rock Hill, S. C.). Radiol. Technol., 37: 51-5(Sept. 1965).**

It was demonstrated that a specific tissue thickness would absorb ½ the amount of 110-KV x radiation impinging upon it. With water in a phantom as the absorbing medium, the water level was varied in 4-cm steps and a radiograph was made for each 4-cm variation in depth. The time of exposure for each test radiograph was doubled for each 4-cm increase in tissue depth and all other factors remained unchanged. A series of experimental radiographs of the phantom with water level variations representing tissue depths of from 4 to 28 cm showed the density of the film to be slightly lighter as the level of the water was increased, indicating that the correct thickness was less than 4 cm. The experiment was repeated using 3.5 cm as the variable thickness factor changing the water level accordingly over a range of from 3.5 cm to 28 cm. Visual inspection of test radiographs showed a consistent film density. This experiment showed that a tissue thickness somewhere between 3.3 and 3.8 cm absorbed ½ of the radiation of an exposure. For practicality, a working figure of 4 cm was selected for standardizing a technique. The theory was applied to radiographic technique for body parts and a chart was produced in which only the time of exposure varied. This technique when applied to radiography of the human body proved to be simple, easy to use, and time saving. It produced consistent, accurate, dependable radiographs of children and adults without conversion of any other factors. (BBB)

4955 RAPID DETERMINATION OF BERYLLIUM BY A DIRECT-READING ATOMIC ABSORPTION SPECTROPHOTOMETER. **Bokowski, D. L. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Amer. Ind. Hyg. Ass. J., 29: 474-81 (Sept.-Oct. 1968).**

A sensitive and specific analytical method for beryllium in air, swipe, biological, and packing material samples was developed. A single-beam atomic absorption spectrophotometer and high-temperature nitrous oxide-acetylene flame is used. The chemical technique for sensitivity enhancement and decontamination from radionuclides is described. Maximum time expenditure for an analysis is less than 30 minutes. Multiple samples may be run in the same time period. Sensitivity of the method is less than 0.04 parts per million of beryllium with a repeatability of approximately 2% of the amount present. Decontamination factors for uranium and transuranium elements were greater than 5000. (auth)

4956 FIRST AID AND SANITARY ADMINISTRATION SERVICE. NOTE III. DESIGN OF RADIOLOGY AND PHYSICAL THERAPY UNITS FOR INFIRMARY. **Crespi Porro, R. (Ospedale di Circolo, Varese, Italy). Minerva Med., 59: 3786-3801 (Sept. 12, 1968). (In Italian).**

The radiological and physical therapy units for a model industrial infirmary are described. The most important problems in the organization of an industrial health service are examined. A model is given for a plant infirmary. (J.S.R.)

4957 OCCUPATIONAL HAZARDS IN X-RAY ANALYTICAL WORK. **Lindell, Bo (National Inst. of Radiation Protection, Stockholm). Health Phys., 15: 481-6(Dec. 1968).**

A preliminary report is given of information on the occupational hazards of X-ray analytical work as obtained from an inquiry in connection with a planned revision of the existing ICRP recommendations. (auth) (UK)

4958 DOSE DISTRIBUTIONS IN PHANTOMS EXPOSED TO 2.95-MeV NEUTRONS. **Clifford, C. E. (Biological and Radiation Establishment, Ottawa). Health Phys., 15: 527-34 (Dec. 1968).**

Fast-neutron and associated gamma dose distributions were measured in cylindrical, slab and spherical phantoms of tissue-equivalent material exposed to a broad beam of 2.95-MeV neutrons. The effect of different phantom geometries on the fast-neutron depth-dose distributions was small. In the cylinder and slab the distributions were about 15% less than that calculated by Snyder and Neufeld for an infinite slab exposed to 2.5-MeV neutrons and were in agreement with depth-dose calculations of Auxier, Snyder and Jones for a 30-cm diameter cylinder exposed to 2.5-MeV neutrons. The associated γ-dose distributions, however, were highly dependent on the choice of phantom size and shape. At depths greater than 20 cm in a 36-cm diameter cylinder the γ-contribution became the largest component of the total dose. The depth distributions of the associated γ-dose were compared with the epithermal neutron distributions indicated by the response of a Cd-covered γ-detector. (auth) (UK)

4959 PROBLEMS OF RADIATION AND HYGIENE IN ENCLOSED SPACES: SUBMARINES. **Lambert, R. J. W. (Royal Naval Medical School, Gosport, Eng.). Ann. Occup. Hyg., 11: 347-55(Oct. 1968).**

Control of the atmosphere, and radiological control, are discussed as two aspects of the environmental control required in the relatively new ecology of the nuclear submarine. The extent of the problem is outlined, and a description is given of the general principles used. Problems that have been encountered in the past, as well as those still in evidence, are mentioned in order to give some measure of the task involved. (auth) (UK)

4960 DETECTION OF RADIONUCLIDES OF BIOLOGICAL INTEREST IN HUMAN BONES AND TISSUES. **Mutschke, Ursula; Pribilla, O. (Christian-Albrechts-Univ., Kiel). Progr. Chem. toxicol., 3: 245-303(1967).**

A review is presented of the following topics: chemical processing and separation of radionuclides in biological material, including sampling and incineration; determination of radionuclides, especially ^{89}Sr and ^{90}Sr (original method of Harley, Bryant's method for radiostrontium in human bone, and the method of Weiss); radiochemical determination of ^{137}Cs, ^{131}I, ^{226}Ra, Th, U, and ^{239}Pu; instrumentation; and results of measurements. The discrimination factor of the Sr in relation to the Ca from the food of the mother to the fetus is considered. Yearly averages for ^{90}Sr contaminations in bone, arranged according to age, are shown. The largest deposition of ^{90}Sr occurs in the first years of growth, corresponding to the rapid growth of bones and the great absorption of Ca in this period. The deposition of fallout ^{90}Sr in human bones is not continuous with age. At puberty there is an increase

in the deposition of ^{90}Sr, which corresponds to the long-growth of bones and the increased Ca metabolism. Contamination of ^{90}Sr in children between 0 and 5 yr of age reaches a maximum yearly average of 5.4 pCi/g Ca. Since the resumption of ground testing of nuclear weapons in the autumn of 1961 the contamination of the biosphere has so increased that the effect is even noticeable in adults. The concentration of radionuclide from human bone samples was used to estimate the bone burden in mrem/yr for each age group. The radiation burden of the age group 1 to 5 yr is about 80 mrem/yr or 8% of the maximum permissible dose. The burden on fetus and 10-day old babies as well as on children between 6 to 20 yr is about half as much. The additional radiation burden on adults of 20 yr and above is relatively small, since it makes only about 1% of the maximum permissible doses. 75 references. (BBB)

4961 SOME PROBLEMS OF RADIATION PROTECTION IN SPACE FLIGHTS. PART 3. Swart, H. Astron. Raumfahrt, No. 2, 57-64(1967). (In German).

This article is the third in a study devoted to radiation problems involved in manned space flights. Both Western and Soviet data and experience are considered. The protective measures are discussed in four principal categories, i.e., shielding, radiation monitoring and warning, spacecraft dosimetry, and the medical-chemical protective means available to the astronauts. Solid shielding materials, i.e., lead, copper, aluminum, beryllium, carbon, polyethylenes, water, and liquid hydrogen, are analyzed with regard to their protective capacity. A human tolerance of 25 rem and maximum exposure limit of 200 rem is assumed. The design and material of space suit, helmet, and glasses are studied, and the protection of food, water, fuel system, instrumentation, etc., are examined with respect to the spacecraft casing and the need for special shielding of critical spacecraft sections. Solar proton flare hazards are discussed in the light of interplanetary flight projects to Mercury, Venus, Mars, and Jupiter. Magnetic and plasma shielding systems are analyzed and a diagram showing a comparison between the mass capacity of solid, magnetic, and plasma systems is presented. Radiation monitoring and warning systems based on and operated from the earth, and the spacecraft dosimetric equipment are described; a reference suggests that Leonov's space walk was carried out only after a reliable radiation search of the area. A table of flight duration and radiation accumulation data based on the space flights of six Soviet astronauts is given. Similar data on the Kosmos 110 Biosatellite are briefly mentioned. In the concluding section, the biological effects of high-energy protons are analyzed, and protective measures as well as radiation syndrome therapy are discussed. Soviet experiments at Dubna with animals exposed to highly accelerated protons are mentioned. A table of protective pharmacological chemicals for the prevention and treatment of radiation syndromes is given. (JPRS)

4962 PATIENT SAFETY OBSERVED IN DENTAL X-RAY EXAMINATION. Asgis, Alfred J. N. Y. J. Dent., 38: 83(Mar. 1968).

Recent unfavorable publicity in the daily press, exaggerating the dangers to the patient's health in dental x-ray examination, is criticized, and it is pointed out that dental x-ray diagnosis with modern equipment and techniques are completely safe. Scare news and sensationalism about health hazards of x rays should not be permitted to deprive the public of the positive benefits of the dental x-ray examination. The American Dental Association has made it clear that the stories in the newspapers about dental x-ray hazards are misleading and incompatible with available facts. It stated that dental x rays should be used judiciously, emphasizing that the dental patient should rely on the judgment of his dentist whether his particular condition requires the use of medication, anesthetics, and such diagnostic tools as x rays. (BBB)

4963 DERMATOLOGICAL PROBLEMS AS CONCERNS THE FITNESS TO A WORK INVOLVING THE IONOGENIC RADIATIONS RISK. Richi, E.; Strambi, E. Securitas, 52: 101-10(1967). (In Italian). (RT/PROT-(68)3).

The workers of a Nuclear Research Centre were regularly examined during a five years period; 1,396 pre-employment medical examinations and some 6,000 following controls were carried out. Skin diseases caused a restriction in work involving a contamination hazard in 6 pre-employment and in 10 following examinations. On the basis of the recent scientific knowledge, the problems related to the dermatological evaluation of qualification for radiation work are then discussed. (auth)

4964 DETERMINATION OF ^{47}Ca AND ^{85}Sr IN BIOLOGICAL SAMPLES BY DIRECT COUNTING. Harmut, M.; Maljkovic, T.; Kostial, K. (Inst. of Medical Research, Zagreb). Arh. Hig. Rada Toksikol., 19: 61-5(1968).

Radioactivity due to the presence of ^{47}Ca and ^{85}Sr was determined before and after ashing of various biological specimens (carcass, skeleton, urine, and feces of rats). By using a scintillation counter with an assembly of two NaI(Tl) crystals and properly adjusting the volume of standards, values for the percentage of radioactivity retained in the body and excreted in urine and feces were obtained which were the same (within statistical fluctuations) for both ashed and nonashed specimens after a single intraperitoneal, single peroral, or repeated peroral administration of the radioactive tracers. (JPRS)

4965 EXPOSURE OF EMBALMERS AND PHYSICIANS BY RADIOACTIVE CADAVERS. Laughlin, John S.; Vacirca, Sal J.; Duplissey, James F. (Memorial Hospital for Cancer and Allied Diseases, New York). Health Phys., 15: 451-5(Nov. 1968).

Experience on the radiation exposure received by undertakers in the embalming of radioactive cadavers, and that received by pathologists during autopsies, is described. Related radiation safety problems for several different radionuclides are discussed. It was proposed earlier that the discharge of radioactive patients and of cadavers be governed on the basis of exposure, rather than on a fixed amount of radioactivity. Since exposure from radioactive cadavers is a continuing and increasing problem, and the use of radionuclides with different half-lives is increasing, it was thought worthwhile to put earlier findings in publishable form. For "radioactive cadavers" whose surface exposure dose rate was more than 30 mR/hr the policy was initiated at Memorial Hospital in 1956 of requiring embalmers to perform their work in the hospital morgue under supervision. During each supervised embalming the undertaker and his assistants each wore two calibrated pocket dosimeters. During the immediately preceding 1-yr period 16 cadavers with radioactive iridium were embalmed under supervision. On the basis of measurements and general considerations with respect to the handling of cadavers it appears advisable that radiation safety precautions be recommended when the exposure rate exceeds a specified amount, rather than on the basis of a radioactivity content of 30 mCi in the body irrespective of the radionuclide, as presently recommended. (auth) (UK)

4966 PROJECT OF THE PERSONNEL MONITORING OF EXTERNAL EXPOSURES. Spurny, Z. (Nuclear Research Inst., Prague). Jad. Energ., 14: 387-9(1968). (In Czech).

The final change of the irradiated organism is not proportional to the sum of the dose equivalents of single irradiation, but to a certain smaller value, defined in this paper as effective dose equivalent-Rem_{ef}. This value could be registered by a dosimeter with a fading of the same magnitude as the restoration rate of the critical organ. The mechanical model for expressing this quantity in connection with today's practice of the personnel monitoring of external exposures was discussed. (auth)

4967 QUESTIONMARKS CONCERNING RADIATION. Dolezal, V.; Luxa, J. (Inst. of Aeronautical Medicine, Prague). Radar (Prague), No. 1, 49-51(Mar. 1968). (In Czech).

Medical problems of cosmic radiation are reviewed. The protection provided by the atmosphere of the earth is discussed. Up to an elevation of 10,000 meters the atmosphere provides sufficient radiation protection. The nature of the ionization by cosmic radiation, galactic cosmic radiation, ionization generated by solar eruptions, and secondary radiations are discussed. Medically acceptable maximum radiation exposures are reviewed. The amounts of radiation to which various astronauts were exposed are discussed. (JPRS)

4968 PROTECTION OF THE GONADS IN PELVIC RADIOGRAPHY. Schulze, K. J. (Orthopaedische Klinik, Dresden). Beitr. Orthop. Traumatol., 13: 689-92(Nov. 1966). (In German).

The use of a Pb capsule to shield the gonads during x-irradiation studies with infants and young children is described. The shield described has a Pb equivalent thickness of 1 mm. It is fastened to the patient's body by means of a plastic belt, and does not in any way interfere with the x-ray picture obtained. There is no difficulty encountered in placing the shield properly in male children. The position and topography of the ovaries change considerably within the region of the sacrum, ilium, and symphysis during the first few yr of life. In the very young child the ovaries are located in the lateral abdominal region in the wings of the ilium. In the second and third yr of life they are located in the lumen of the minor pelvis and approach closer to the midline. The shield must cover the entire pelvis as far as the symphysis. Stray radiation must be shielded out by extending the shield beyond and around the waist of the body. The shield should be placed on the body so that the iliac spine is covered anteriorly from above and back, and fixed to the body with elastic or steel bands. (BBB)

4969 DETERMINATION OF THE ABSORBED DOSE OF VARIOUS TYPES OF RADIATION ON THE BASIS OF THE RE-

CORDED PARTICLES AND THE MEAN ENERGY OF THE ACTIVE SPECTRUM. Lyapidevskii, V. K.; Linchevskaya, G. A. (Roentgenological and Radiological Scientific Research Inst., Moscow). Med. Radiol., 13: 72-8(June 1968). (In Russian).

Although the methods used for the dosimetry of α, β, γ, p and n radiations consider the individual radiations separately, they are all based on the principle of the measurement of the energy loss by primary or secondary charged particles during their passage through the tissue. The problems encountered in the determination of "hard" and "soft" radiations are reviewed individually. A correlation is derived between the mean energy of the spectrum in the tissue and in the material of the detector. Distribution of the depth dose may be calculated from the half-thickness values and the attenuation data. A criterion was also obtained for determining the correlation between the plotted and actual acting distribution. (TTT)

4970 INVESTIGATION OF DOSE DISTRIBUTION ON IRRADIATION WITH A ^{60}Co TELE-IRRADIATOR. Gantchew, Michael; Naumova, Zwetana (Onkologische Forschungsinstituts, Sofia). Strahlentherapie, 135: 534-8(May 1968). (In German).

The results of a study concerning dose distribution of a ^{60}Co γ teletherapy beam are reported. It is shown that the tables from Suppl. 10 of the Brit. J. Radiol. could be applied if the geometrical field is identical with the physical field. This depends on the construction of the diaphragm, on the source diameter, and on the field size. (auth)

4971 RISK FROM SUPERNOVAE COMPARED WITH RISK STANDARDS FOR NUCLEAR REACTORS. Bowen, J. H. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nature (London), 220: 303-4(Oct. 19, 1968).

Farmer (IAEA Symposium on Containment and Siting of Nuclear Power Reactors, April 1967) states that the permissible frequency for the largest reactor accidents appears to be in the range 10^{-6} to 10^{-8} (reactor years)$^{-1}$, depending on the system of extrapolation for risk versus accident size. Terry and Tucker (Science 159: 421(1968)) estimated that the explosion of supernovae may produce lethal doses of radiation from cosmic rays with a frequency of 2×10^{-8} yr^{-1}. The event considered by Terry and Tucker is incomparably more serious than that considered by Farmer and might imply the extinction of human life on Earth. If this is correct, Farmer's standard would seem too severe. It is suggested, however, that interpretation of Terry and Tucker's finding in this sense is unjustified because of the forewarning to be expected of the radiation from supernovae events, and it is assumed that, within the warning time of 1 year between the arrival of light and radiation, shelter could be improvised for the human population. A dose of 50 R should then not be exceeded at a frequency higher than 2.5×10^{-9} yr^{-1}, and a dose of 500 R at a frequency higher than 10^{-10}/yr^{-1}. It is suggested that these conclusions are not incompatible with the standards discussed by Farmer in the reactor context. (UK)

4972 TRUDY PO RADIATSIONNOI GIGIENE. VYPUSK 3. (Reports on Radiation Protection. Third Edition). Nevstruevoi, M. A. (ed.). Leningrad, [Ministry of Public Health), 1967.

Articles are included on the work and data obtained during the 10-yr period (1957–1967) by the Leningrad Scientific Research Institute on Radioprotection. Included are new methods and instrumentation developed during this period. The effects of ionizing radiation on man exposed to chronic low-level external and internal radiation are discussed and the metabolism, biological effects, and permissible doses of the fission fragments ^{90}Sr, ^{144}Ce, ^{137}Cs, and U are presented. The problems of radioprotection of personnel working in proximity of nuclear reactor, waste disposal, and effects of incorporated isotopes on immunity are discussed. Measurement methods for integral dose absorption by organs and their simulation by tissue-equivalent scintillation transducers in phantoms, properties of organic scintillators for x- and γ-ray dosimetry, α-spectrometer based on series of blocks and its uses in radiobiological studies are studied. Aspects of radiation protection under conditions of the Far North during 1959–1965 and the analysis of ^{90}Sr and ^{137}Cs in the environment in 1960–1966 are also considered. (R.V.J.)

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Refer also to abstracts 4802, 4878, 4900, 4943, 4951, 4954, 4956, 5012, 5017, 5025, 5030, 5034, 5041, 5042, 5046, 5048, and 5051.

4973 (COO-1422-21) MEASUREMENT OF BONE MINERAL BY THE DIRECT PHOTON ABSORPTION METHOD: PRINCIPLES AND INSTRUMENTATION. Cameron, John R.; Sorenson, James A. (Wisconsin Univ., Madison. Dept. of Radiology). Feb. 15, 1968. Contract AT(11-1)-1422. 24p. (CONF-680211-1). Dep. CFSTI.

From Conference on Progress in Methods of Bone Mineral Measurement, Bethesda, Md.

Radiation sources used were ^{125}I, ^{241}Am, and ^{210}Pb. Factors to be considered in choosing a low energy photon beam as a source are discussed. A diagram is presented to show the basic principles used in measuring bone mineral with a monoenergetic source. An equation is given for determining bone mineral mass per unit area in the radiation beam path. Another figure shows a scheme of the system with the limb containing the bone of interest surrounded by tissue equivalent material. As the source and detector move across the limb the number of counts reaching the detector will depend upon the absorption characteristics of the material in the beam. A typical graph is presented for the change of count-rate as the beam passes across the bone. The technique was evaluated using excised bones of different sizes immersed in water. An electronic computer was used for processing the data from measurements collected. (H.L.W.)

4974 (NSJ-tr-120) STUDIES ON THE THYROID FUNCTION TEST BY MEANS OF WHOLE BODY LINEAR SCANNING. Osiumi, Yosihiko; Matsuura, Keiichi; Kiyonari, Hideyasu; Kawanami, Hisashi; Inakura, Masataka. Translated from Nippon Igaku Hoshasen Gakkai Zasshi, 26: 1462-70(1967). 16p. Dep.

Whole-body linear scanning 1, 3, 6, and 24 hours after oral administration of Na^{131}I was used as a test of thyroid function. Results indicated that ^{131}I distribution in the body changed with time and thyroid function. The curve of whole-body scans had two remarkable peaks. The one showing the amount of ^{131}I taken up by the thyroid gland was in the area corresponding to the thyroid gland. The other was between the xyphoid process and umbilicus, which represented ^{131}I distributed in many organs such as stomach, liver, spleen, pancreas, and small intestine. It was concluded that the stomach plays the most important role for the activity represented by the latter peak. Results indicated that the peak recognized between the xyphoid process and umbilicus showed exactly the condition of thyroid function on 6 hours after administration of ^{131}I. (C.H.)

4975 CYTOLOGICAL PICTURE OF THE CERVICAL EPITHELIUM AFTER INTRAVAGINAL APPLICATION OF RADIOACTIVE MINERAL SPRING WATER. Wawrzkiewicz, Marian; Baron, Adam (1st Obstetrics and Gynecology Clinic, Wroclaw). Ginekol. Pol., 36: 927-9(Aug. 1965). (In Polish).

Only certain gynecologic disorders were considered suitable for radioactive balneological treatment. Cytologic observations were made on 26 females, aged 21 to 50 yr, recommended for balneologic therapy of intravaginal epithelial sores, to determine the effects of radioactive mineral water. The experimental treatment included 12 intravaginal infusions, by injecting 14 liters of radioactive mineral water at 39°C for 15 min. The average monthly radioactive dose from water at the Swieradow Spa was measured as 7.43 μCi/l, along with a content of 2196 mg/l of CO_2 and 366 mg/l of HCO_3^-. The evaluation of cytologic effects in cervical epithelium indicated that in 76% of the patients antiinflammatory and regressive changes developed. No changes and no adverse reactions were found in other patients. It was evident that hot radioactive mineral water infusions, in addition to having cleansing effects, induced a slight hyperemia in affected tissues, thus contributing to a more favorable cytological picture. No doubt, other factors also had their beneficial effects, e.g., mechanical removal of atrophied tissues and intravaginal massage, which, along with the antiphlogistic, desensitizing, and analgesic properties of the radioactive water, improved the general symptoms of patients and increased the function of the adrenal cortex. In turn, the latter may have reacted favorably against the hormonal impairment of the ovaries which then influenced the cervical endothelial cytologic response. (BBB)

4976 INFLUENCE OF RADIOPROTECTORS (ADRENALIN, MORPHINE, SODIUM NITRITE) ON THE LEVEL OF PROTEIN SULFHYDRYL GROUPS IN MOUSE BONE MARROW CELLS. Dontsova, G. V.; Graevskii, E. Ya. (Inst. of Developmental Biology, Moscow). Radiobiologiya, 8: 630-2(1968). (In Russian).

Changes in the content of protein sulfhydryl groups in mouse bone marrow cells under the influence of the radioprotectors, adrenalin, morphine, and sodium nitrite were investigated. The quantitative determination of protein SH-groups was performed cytophotometrically on an MF-4 cytophotometer with preliminary staining of the bone marrow cells with the reagent diazole black K according to the method of Barrnett and Seligman. The average values of the extinction, obtained after the administration of the radioprotectors, were higher than the average values of the extinction in the normal state and were close to the values obtained

in experiments with anoxia. The materials presented are evidence that all the protectors studied distinctly increase the level of protein SH-groups in the bone marrow cells of mice during the period of their maximum radioprotective activity. (JPRS)

4977 STUDIES OF THE LIGHT REACTIONS OF PSORIASIS PATIENTS. Szabo, Eva; Horkay, Irene (Univ. Skin Clinic, Debrecen, Hungary). Z. Haut- Geschlechtskr., 39: 425-9(Dec. 1965). (In German).

Effects of uv irradiation on psoriatic and other dermatologic patients were studied by exposure to a 3600-Å maximum wavelength uv lamp. The average length of exposure to uv irradiation required to produce erythema in the patients with eruptive psoriasis was 130 sec, and it was 50 sec in patients with discoid psoriasis. In normal patients it was between 1 and 1½ min. In some of the patients with eruptive psoriasis the time required was as high as 8 to 10 min, and only one patient from this group required less than 1 min. The average value was greater than for patients with allergic diseases. Tranquilizers given along with localized treatment for the psoriasis had no effect on the amount of uv irradiation required to produce erythema. (BBB)

4978 ELIMINATION OF URINARY STEROIDS AND THE METOPIRONE TEST AFTER HYPOPHYSECTOMY FOR HORMONE-DEPENDENT CANCERS. Soulairac, A.; Talairach, J.; Schaub, Cl.; Aymard, N.; Bonis, A.; Szikla, G. (Hopital Sainte-Anne, Paris). Ann. Endocrinol. (Paris), 28: 101-10(Jan.-Feb. 1967). (In French).

The effect of ^{90}Y irradiation of the pituitary on adrenal steroid metabolism was studied in 150 patients, mostly with metastatic breast cancer. It was shown that following ^{90}Y hypophysectomy, urinary steroids vary in different ways according to whether or not diabetes insipidus has developed. In patients that were hypophysectomized and did not develop diabetes insipidus, there was a decrease in the concentration of steroids (17-hydroxycorticosteroids and 17-ketosteroids (per liter of urine)), while urine volume was decreased. When diabetes insipidus was produced, the same decrease in steroid concentration was seen, but as the volume of urine was considerably increased, daily elimination of steroids exceeded the preoperative rate. In both groups the metopirone test was negative. The importance of these data in the analysis of the function of the hypothalamo-hypophysio-adrenal axis and the interpretation of the therapeutic effects of hypophysectomy in hormone-dependent cancer are discussed. (BBB)

4979 DIAGNOSIS AND THERAPY OF DISEASES OF THE THYROID USING RADIOISOTOPES. Riccabona, G. (Univ., Innsbruck). Wien. Klin. Wochensch., 80: 701-7(Sept. 20, 1968). (In German).

The principles, methods, and results of radioiodine diagnosis and therapy of thyroid diseases are briefly described in order to inform general practitioners of the possibilities and limitations of this technique. (J.S.R.)

4980 TREATMENT OF ACUTE LEUKEMIA BY ALLOGENIC BONE MARROW GRAFT. Mathe, George; Amiel, Jean-Louis; Schwarzenberg, Leon; Cattan, Albert; Schneider, Maurice (Hopital Paul-Brousse, Villejuif, France). Progr. Clin. Cancer, 3: 309-19(1967).

Experimental and clinical studies on the use of whole-body irradiation and bone marrow transplantation in the treatment of leukemias are presented. The experiments were done in F1 (C57Bl6 X DBA2) mice given a graft of 10^4 cells of L 1210 leukemia. Four hr after the transplantation the mice were submitted to total x irradiation with 850 R, and 4 hr after irradiation, 10^7 medullary C57Bl6 cells were transplanted by intravenous injection. The results were compared with those obtained by transplantation of bone marrow from F1 (C57Bl6 X DBA2) donors. Mean survival was considerably longer when the irradiation was associated with an immune reaction of C57Bl6 cells against the DBA2 leukemic cells. At postmortem, 35% of the mice which died after the 20th day showed no sign of leukemia but had histologic lesions of the secondary syndrome. In another experiment, in which the secondary syndrome was treated with amethopterin or cyclophosphamide in doses ineffective against leukemia (2 and 180 mg/kg respectively, every other day from the 15th to 33rd day after irradiation), the number of cured mice was considerably larger. Similar experiments, with total irradiation at lethal doses followed by transplantation of allogenic bone marrow, were carried out in mice with spontaneous AkR leukemia. The animals received 750 R followed by transplantation of hemopoietic cells from donors C3H or C57Bl6 (adults or fetuses). Mean survival time was not prolonged, but, in fact, shortened as compared with that in controls. At postmortem, however, most mice showed no histologic sign of leukemia, but had various lesions of the secondary syndrome, responsible for their deaths. Other F1 mice (DBA 2 X CBA) were treated 4 hr after Friend virus inoculated by total irradiation with 950 R, followed by transplantation of either 10^7 isogenic or allogenic marrow cells (C57Bl6) 4 days later; 0.3 ml blood was obtained and intravenously injected into F1 mice (DBA2 X CBA). In the group inoculated with the blood from mice treated with isogenic bone marrow, 100% of the animals died of leukemia. In the group inoculated with blood from mice treated with allogenic bone marrow, 33% of the animals showed no leukemia, indicating that active virus may be eradicated in the blood of allogenic radiochimeras. Clinical trials are also described. (BBB)

4981 HEPATIC SCINTISCANNING: COMPOUNDS USED. O'Mara, Robert E. (State Univ. of New York, Syracuse). N. Y. State J. Med., 68: 3021-7(Dec. 1, 1968).

Although there is room for considerable improvement in the instrumentation and technique of hepatic scanning, this scanning represents an extremely valuable addition to the evaluation of the patient with undiagnosed or suspected liver disorders. It is a simple and relatively safe procedure from which a great deal of information may be obtained. (auth)

4982 THE YEAR BOOK OF NUCLEAR MEDICINE. VOLUME 2. Quinn III, James L. (ed.). Chicago, Year Book Medical Publishers Inc., 1967. 384p. $10.00.

The second annual volume of Nuclear Medicine consists of a number of articles intended to represent the pulse of the field in 1967. Nuclear medicine is defined as the clinical discipline concerned with the diagnostic, therapeutic, and investigative uses of radionuclides. It does not include the therapeutic use of sealed radiation sources. Book organization is by the body systems involved, with introductory articles covering, health physics, instrumentation, radiation chemistry and physics, radiobiology, and radiopharmacology. (C.O.)

4983 THE YEAR BOOK OF NUCLEAR MEDICINE. VOLUME 3, 1968. Quinn III, James L. (ed.). The Practical Medicine Year Books. Chicago, Year Book Medical Publishers, Inc., 1968. 427p. $10.50.

The third annual volume of Nuclear Medicine collects articles believed to be of particular interest in the field in 1968. In addition to the articles covering developments in the basic related sciences and those covering applications to the various body systems, an article on dynamic function studies is included. (C.O.)

4984 RADIOBIOLOGY OF HUMAN CANCER RADIOTHERAPY. Andrews, J. Robert. Philadelphia, W. B. Saunders Company, 1968. 279p. $19.00.

After consideration of the biophysical mechanisms involved in radiation biology and the problems of dosimetry, the basis of radiation lethality to cells is discussed. Radiosensitivity and the factors that affect it are reviewed on the cellular level stressing human cells, as well as within the dynamics of cell populations. Radiation effects on the various organs and tissues of the human body and on hemopoiesis and the development of the radiation syndrome are considered. The oxygen effect is discussed and the concepts of LET and radiation response are presented. Relationships of dose, dose fractionation, and time are considered. Problems in cancer therapy by drugs and radiation and the human implications of cellular radiobiology are also presented. A numbe of illustrations and an extensive bibliography are given. (C.O.)

4985 ANTIRADIOMIMETIC EFFECTS OF CERTAIN NATURAL COMPOUNDS. I. TOTAL PREPARATIONS AND INDIVIDUAL GLYCOSIDES OF THE GINSENG ROOT. Brekhman, I. I.; Ganenko, V. A. (Inst. of Biology of Active Substances, Vladivostok, USSR). Radiobiologiya, 8: 613-15(1968). (In Russian).

Substances were investigated simultaneously in several concentrations on a radiomimetic erythrocytic model with oxidized oleic acid. The activity of an amount of the preparation that halves the time of hemolysis of 50% of the erythrocytes under definite experimental conditions was taken as one antiradiomimetic activity unit (ARMAU). The activity of a mixture of panacosides ($2.2 \cdot 10^4$ ARMAU), that of the polysaccharide fraction ($1.3 \cdot 10^4$ ARMAU), and those of six individual panacosides ($1.4\text{-}7.1 \cdot 10^4$ ARMAU) of the ginseng root was higher than the activities of mercamine ($3.4 \cdot 10^3$ ARMAU) and ionol ($1.3 \cdot 10^4$ ARMAU). (JPRS)

4986 CARCINOMA OF THE MALE BREAST FOLLOWING RADIATION. REPORT OF A CASE OCCURRING 35 YEARS AFTER RADIATION THERAPY OF UNILATERAL PREPUBERTAL GYNECOMASTIA. Lowell, David M.; Martineau, Roland G.; Luria, Sidney B. (Waterbury Hospital, Conn.). Cancer, 22: 581-6(Sept. 1968).

A 46-yr old Caucasian man with carcinoma of the right breast received therapeutic x radiation to the same breast for prepubertal gynecomastia some 35 yr previously. The carcinogenic effects of

irradiation are reviewed with respect to occupational exposure and diagnostic and therapeutic iatrogenesis. Epidemiologic factors in the etiology of carcinoma of the male breast are considered, especially those related to abnormalities in the metabolism of estrogen, both exogenous and endogenous. It is felt that the therapeutic irradiation was significant in the development of mammary carcinoma in this patient. (auth)

4987 ^{192}Ir AND ^{137}Cs IN THE PERSPECTIVES OF RECENT DECREES ON PROTECTION AGAINST IONIZING RADIATIONS. Pierquin, B.; Chassagne, D. J. Radiol., Electrol., Med. Nucl., 49: 533-4(June-July 1968). (In French).

Recent edicts on the medical uses of sealed sources in France will have the effect of making the use of radium impractical. Iridium-192 can replace advantageously Ra in the large radiotherapy centers. Cesium-137 can replace Ra in the small radiotherapy centers. In spite of the advantages in the replacement of Ra by ^{192}Ir and ^{137}Cs, the new legal edicts on the protection should increase considerably the investment and operating costs of radiotherapy centers. (J.S.R.)

4988 FIRST AID FOR INJURED PERSONNEL. NOTE II. INDUSTRIAL INTOXICATION–RADIOACTIVE DECONTAMINATION. Crespi Porro, R.; Montoli, E. (Ospedale di Circolo, Varese, Italy). Minerva Med., 59: 3770-85(Sept. 12, 1968). (In Italian).

The first aid treatment to be administered in the case of industrial poisoning by arsenic, mercury, gold salts, phosphoric esters, and cyanides is described for each substance. In the case of radioactive contamination the first aid treatment is given for cases with and without injuries. The decontamination procedure itself is described. (J.S.R.)

4989 ESTIMATING THYROID IODINE BY ACTIVATION ANALYSIS IN VIVO. Lenihan, J. M. A. (Western Regional Hospital Board, Glasgow); Comar, D.; Riviere, R.; Kellershohn, C. J. Nucl. Med., 9: 110-15(Mar. 1968).

The technique described gives satisfactory results when used for estimating the thyroid iodine content of the animals in vivo, and it is reasonable to envisage its extension to human subjects. By shortening the irradiation time and by adding additional shielding to reduce the gamma radiation from the reactor core which contaminates the neutron beam, the irradiation dose can be reduced to a level comparable with that accepted in a routine tracer test with ^{131}I. In the arrangement described, the flux of epithermal and fast neutrons accompanying the thermal-neutron beam gives a negligible radiation dose. On the basis of the experiments described here, it is believed that the neutrons produced by the EL3 reactor at Saclay will allow an accurate estimate of thyroid iodine in human subjects using activation analysis in vivo. (auth)

4990 EFFECTS OF RADIATION ON OLIVE OIL. Astudillo, M. D.; Funes, E.; Sanz, F. (CSIC, Madrid). An. Quim., 64: 787-9(July-Aug. 1968). (In Spanish).

The effects of gamma radiation on control samples of olive oil and other samples with the antioxidants BHA and α-tocopherol (0.05%) were studied. The radiation doses used were 5, 10, 20, and 30 MRADS, and the radioprotective effect was compared in that of 10 MRAD. The antioxidants did not protect at the concentrations and doses used. It was seen that the peroxide index decreased with increased doses of radiation and the carbonyl values increased slowly simultaneously with an increase in the absorption at 270 mμ and that the absorption at 232 mμ increased progressively also. (tr-auth)

4991 DEVICE FOR MEASURING LINEAR ACTIVITY. Bernard, M. (Faculte des Sciences, Limoges, France); Dutreix, A. J. Radiol., Electrol., Med. Nucl., 49: 534-7(June-July 1968). (In French).

A device for the measurement of the linear activity of wires and pins in their different initial form, and if necessary, in their different parts was designed and constructed. The principles of the device are reported and the detection system is described. The tests made with ^{192}Ir to determine the validity of the responses of the linear activimeter are discussed. The device can be used with other radioelements and its precision is better than 3%. (J.S.R.)

4992 THEORETICAL CONSIDERATIONS OF CONDITIONS FOR HIGH RESOLUTION RADIOISOTOPE SCANNING. Whittingham, T. A.; Mallard, J. R. (Univ. of Aberdeen, Scotland). Phys. Med. Biol., 13: 657-60(Oct. 1968).

Calculations are presented which can be used to estimate the increase in concentration ratio required between target and non-target areas in order to visualize objects at finer resolution in the same time as at coarse resolution. (UK)

4993 CRITICAL ANALYSIS OF THE CONTROL OF MALIGNANT EFFUSIONS WITH RADIOISOTOPES. O'Bryan, Robert M.; Talley, Robert W.; Brennan, Michael J.; Diego, Emiliana San (Henry Ford Hospital, Detroit). Henry Ford Hosp. Med. J., 16: 3-14(Spring 1968).

Results of treatment with intracavitary ^{198}Au or $Cr^{32}PO_4$ of recurrent malignant effusions in 105 patients are reported. Based on clinical improvement for periods up to 10 weeks and on roentgenographic findings, the overall control rate was 57.1%. Pleural effusions were better controlled than ascites. A better rate of control and a significantly greater length of control was obtained with ^{198}Au than with $Cr^{32}PO_4$. Patients with gastrointestinal malignancy did not respond as well as patients with other primary neoplasms. Similar control rates were seen in patients with or without effusions that contained demonstrable tumor cells. Simultaneous systemic therapy of the malignancy with hormones or chemotherapy, plus intracavitary radioisotopes, did not significantly increase the rate of effusion control over intracavitary radioisotope therapy alone. At the time of therapy, serum protein and serum albumin were significantly higher in patients with effusion control than in patients in whom effusions were not controlled. The mechanisms of effusion development in malignancy were not clear but major operative factors probably included serious irritation and partial lymphatic obstruction. The mechanism of control of effusion by radioisotopes, though not proved conclusively, probably is based on tumor cell inhibition and mesothelial fibrosis. Either ^{198}Au or $Cr^{32}PO_4$ may be effective in the management of patients with malignant effusion and may add measurably to their comfort and ease of care. (BBB)

4994 COMBINED FUNCTIONAL AND LOCALIZATION DIAGNOSIS OF THE THYROID GLAND WITH THE IODINE ISOTOPES ^{131}I AND ^{125}I. Deckart, H.; Tautz, M. (Radiologische Klinik des Staedtischen Klinikums, Berlin-Buch). Deut. Gesundheitsw., 20: 1831-7(Oct. 6, 1965). (In German).

Calculations show that the irradiation received by the thyroid from deposited ^{131}I is ~2 times as great as from ^{125}I. The whole-body irradiation received from ^{131}I deposited in thyroid also is almost twice as much as from deposited ^{125}I. As examples, the thyroid dose from 50 μCi of ^{131}I is 90 R, but it is 42.2 R from 50 μCi of ^{125}I. The whole-body irradiation received from this amount of ^{131}I is 83 mR, and from ^{125}I it is ~60 mR. The reduced irradiation dose from ^{125}I, as compared to ^{131}I is due to its lower γ energy and the absence of β components. The ^{125}I radioisotope also has definite advantages for use in scintigraphy. Its lower energy improves the resolving power, and the absence of Compton effects increases the effectivity of the detector system. (BBB)

4995 A MODIFICATION OF THE TECHNIQUE FOR ^{51}Cr-LABELING OF BLOOD PLATELETS GIVING INCREASED CIRCULATING PLATELET RADIOACTIVITY. Abrahamsen, Arne Foss (Ulleval Hospital, Oslo). Scand. J. Haematol., 5: 53-63 (1968).

The effects of temperature, pH, incubation medium, and incubation time on the uptake of ^{51}Cr by platelets were studied. The uptake of ^{51}Cr proceeded rapidly for at least 4 hr in a modified Ringer solution. The rate of uptake increased with temperature up to 37°C, with platelet concentrations up to 1 to 2 $\times 10^6/\mu$l and with concentration of ^{51}Cr, but was reduced by a surface-active agent, Triton WR 1339. Based on these observations, a modified technique for ^{51}Cr-labeling of platelets is described. Provided the platelet count is normal, removal of only 120 ml of blood from the patient is necessary. Even in severe thrombocytopenia, survival of autologous platelets can be estimated by the method present. (BBB)

4996 SURVEY OF THE NEWEST REPORTS ON LATE DAMAGES CAUSED BY THE ATOMIC BOMB EXPLOSIONS IN HIROSHIMA AND NAGASAKI (1965). Akimoto, S.; Kusano, N.; Nakamura, H.; Shiga, H. Deut. Gesundheitsw., 21: 1206-11 (June 30, 1966). (In German).

The frequency of leukemia cases reported for Hiroshima for the period 1946 to 1964, and fatalities from leukemia are reviewed. Similar statistics are presented for Nagasaki, with additional details of classification according to yr, type of irradiation exposure, and location of exposure. In addition, the number of cases and frequency of leukemia for the period 1946 to 1964 in Nagasaki, classified as to site of exposure in relation to the explosion center, and the type of exposure is presented. Chromosome changes and myeloma incidence in exposed individuals and tumor incidence in Hiroshima classified by organ are reported. Standardized mortality data for malignant neoplasms in the irradiation-exposed population are compared with the incidence of malignant neoplasms in the unexposed portion of the Hiroshima Atomic Bomb Hospital are tabulated for the years 1956 to 1965. The classification of diseases of inpatients at this

hospital is tabulated for the same period. The incidence of leukemia and malignant tumors among inpatients at the Hiroshima Atomic Bomb Hospital, classified according to the site of exposure and the time of leaving the city is tabulated. Diseases of blood forming organs are classified on the same basis. Liver disease incidence among inpatients at the Hospital, classified on the basis of exposure distance and time of leaving the city, is tabulated. (BBB)

4997 MEDICAL UTILISATION OF ^{198}Au. Chateau, D.; Soutter, J.; Vrousos, C. (Service Central de Radiologie des Hospices Civils, Strasbourg). Ind. At., 12: No. 5-6, 66-70 (1968). (In French).

Although replacement of gold with more suitable radioisotopes for therapeutic purposes has occurred, the use of this radioisotope for diagnostic purposes is still widespread. The principles of diagnostic application of ^{198}Au are outlined and the equipment for detection of the γ radiation is described. The use of ^{198}Au for the morphological and functional exploration of the liver and the lymphatic system is considered in some detail. The advantages of ^{198}Au in the exploration of the lymphatic system are summarized. (TSS)

4998 RADIATION INJURIES OF URINARY TRACT. Tsuchiya, F.; Toyoda, Y.; Nakagawa, K.; Miura, M.; Kurotsuchi, M.; Miyamura, R. (Tokyo Teishin Hospital). Nippon Hinyokika Gakkai Zasshi, 57: 1299-1308(Dec. 1966). (In Japanese).

Radiation injuries of the urinary tract and their surgical treatment in the authors' clinic over the last 15 yr are reported. The complications of irradiation included 13 cases of teleangiectasia, 2 of ulceration with ureteral obstruction, 7 of vesicovaginal fistula, 4 of vesicorectovaginal fistula, and 3 of contracted urinary bladder. Cases of teleangiectasia of the bladder were detected at an average of 6 yr after radiation therapy for uterine carcinoma or bladder tumor. The most successful treatment was transurethral electrocoagulation. In some cases ulceration occurred as a result of implantation of Rn seeds for bladder tumor. A case requiring plastic surgery for vesicorectovaginal fistula is reported in detail. The 54-yr-old woman with carcinoma of the cervix received radiation by intracavitary Ra and x rays in an excessive dose. This resulted in a hen's egg-sized vesicovaginal fistula and a walnut-sized rectovaginal fistula. Plastic surgery was not successful because of excessively fibrosed tissues. A new method was therefore attempted; thus, the fibrosed uterus was bisected. Half of the uterus was utilized as a support for bladder sutures and the other half was used to close the rectovaginal fistula. This method achieved a satisfactory result; bladder capacity after the operation was 200 ml. Ileocystoplasty was carried out in 2 cases of a contracted bladder. (BBB)

4999 PROTECTIVE EFFECT OF UROCANIC ACID EYE DROPS AGAINST THE OCULAR INFLAMMATION INDUCED BY ULTRAVIOLET RADIATION. Matsui, Mizuo; Tashiro, Tadamasa (Nihon Univ., Tokyo). Nippon Ganka Gakkai Zasshi, 71: 571-6 (June 1967). (In Japanese).

It was confirmed that urocanic acid has a strong absorptive effect on uv radiation when the skin is irradiated. The protective action of the drug against the ocular inflammation caused by uv irradiation was investigated. Urocanic acid was instilled into the right eyes of 5 rabbits in the form of a 1.0% solution. The left eyes were treated at the same time with nonirritative control eye drops. The uv irradiation of both eyes was then performed by a mercury vapor lamp. The results showed that local administration of urocanic acid could not completely prevent the occurrence of the uv-induced ocular inflammation. However, the degree of inflammation was markedly reduced in the right eyes as compared to the left eyes which were treated with control eye drops. (BBB)

5000 IN VITRO DIAGNOSIS WITH RADIONUCLIDES: LABORATORY MEDICINE WITH A FUTURE. Kuni, H.; Graul, E. H. (Philipps-Univ., Marburg, Ger.). G-I-T (Glas-Instrum.-Tech.) Fachz. Lab., 10: 606-9(July 1966). (In German).

Economic aspects of establishing a diagnostic radioisotope laboratory are discussed briefly, and various typical radioisotope tests such as absorption of radioactive vitamin B_{12}, measurement of intestinal blood loss by ^{51}Cr, kidney function tests, measurement of Fe-binding capacity, measurement of serum K level, estimation of digitalis glycoside serum level by erythrocyte uptake of ^{86}Rb, etc. are mentioned. Various aspects of the ^{131}I-labeled triiodothyronine test for diagnosis of thyroid function are described and discussed extensively. The advantages of this test to diagnose hyperthyroidism are emphasized. The uses of ^{131}I for immunoanalysis of insulin, thyroid-stimulating hormone, somatotrophic hormone, and lutenizing hormone are described briefly. The use of a semiautomatic radioisotope measurement device is discussed extensively. This type of equipment is recommended for laboratories that do not specialize in radioisotope tests alone. (BBB)

5001 SCINTISCANNING IN MALIGNANT LYMPHOMATOUS INVOLVEMENT OF BONE. Weber, William G.; DeNardo, Gerald L.; Bergin, James J. (Fitzsimons General Hospital, Denver). Arch. Intern. Med., 121: 433-7(May 1968).

The use of ^{85}Sr to demonstrate the incidence of bone involvement in lymphomatous diseases is reported. A tracer dose of ^{85}Sr is substituted for Ca and it is concentrated only in the bone. For bone scintiscanning ^{85}Sr is more suitable than the various radioisotopes of Ca because of its physical characteristics. In almost all malignant lesions of bone, osteoblastic and osteolytic, there is an increased accretion rate of Ca and of a tracer dose of ^{85}Sr. This increased uptake is apparent on a bone scintiscan 48 to 72 hr after intravenous injection. Bone roentgenograms usually do not demonstrate an abnormality unless there is a 30 to 50% alteration in the net balance of bone Ca. There can be a significant increase in osteogenesis and osteolysis without any change in net Ca balance. Therefore, early in the disease, it is possible to have a negative roentgenogram and yet a positive ^{85}Sr scintiscan. Obtaining bone scintiscans using ^{85}Sr is a tedious procedure requiring long periods of scanning and, occasionally, repeated scanning for acceptable interpretation. In this study, 84.2% of the patients had bone scintiscans compatible with lymphomatous involvement while only 10.5% had roentgenographic evidence. The ^{85}Sr scintiscan is an excellent means of evaluating early lymphomatous involvement of bone. (BBB)

5002 ^{99m}Tc IN THE STUDY OF THYROID DISORDERS. Abdel-Wahab, M. F.; Ibrahim, M. S.; Megahed, Y. M. (Middle Eastern Regional Radioisotope Centre for Arab Countries, Cairo). Med. Pharmacol. Exp., 17: 305-10(1967).

Six normal subjects and 9 patients with different types of thyroid disease were given a dose of 100 μCi of ^{99m}Tc intravenously. Counting of the radioactivity was done over the thyroid and thigh simultaneously at intervals of 15, 30, 45 min, 1, 2, 3, 4, 24 hr. Urine was collected at 2-, 4-, 24-, and 48-hr intervals. Results indicated that the test is very sensitive, but with much less radiation hazard because of the very short physical half life. These considerations point to the usefulness of ^{99m}Tc as an agent for the diagnosis of thyroid disease, especially in children, and for the study of the physiology of the thyroid. The biological behavior of ^{99m}Tc is very similar to that of iodine. After intravenous injection, both ions penetrate the extravascular space rapidly, and then disappear slowly. Both ions are concentrated to about the same extent by the thyroid gland, salivary glands, stomach, and cerebrospinal fluid, and this selective concentration is abolished by perchlorate ions. The chief difference between the behavior of ^{99m}Tc and iodide is the markedly different excretion pattern. Whereas iodide-^{131}I is almost totally excreted in the urine, ^{99m}Tc is also excreted via the intestine. (BBB)

5003 PRECAUTIONS IN THE USE OF RADIOACTIVE SEEDS. Saylor, W. L. (Walter Reed General Hospital, Washington, D. C.). Phys. Med. Biol., 13: 664-5(Oct. 1968).

It is pointed out that radiotherapists sometimes implant radioactive seeds without performing their own assay, trusting to the supplier's certificate of activity; and it is emphasized that responsibility for the activity and purity of such seeds for interstitial use rests with the user. Three recent experiences with seeds of ^{198}Au, ^{192}Ir, and ^{222}Rn are described. (INIS) (UK)

5004 LES ISOTOPES A L'USAGE DU MEDECIN PRATICIEN. (Isotopes Available for the Medical Practitioner). Frere, Andre G. Brussels, Editions Arscia S. A., and Paris, Librairie Maloine S. A., 1966. 117p.

A book written for the general practitioner on the radioisotopic diagnostic methods available for routine application is presented. Radiodiagnostic tests are described for the thyroid, blood and hematopoietic organs, blood circulation and the heart, lungs, lymphatic ganglions, water and electrolytes, digestive tract, kidney, and brain. Tumor scintigraphy, Ca and Mg metabolism, possibilities of scintigraphy, and color scintigraphy are also described. (J.S.R.)

5005 KLINICHESKAYA RADIOIZOTOPNAYA DIAGNOSTIKA. (Clinical Radioisotopic Diagnostics). Zedgenidze, G. A.; Zubovskii, G. A. Moscow, Izdatel'stvo Meditsina, 1968. 368p.

Principles and methods of clinical radioisotopic diagnostics, techniques for working with radioactive preparations, and radiometric devices are reviewed. Results of studies of thyroid gland, liver, kidney, spleen, cardiovascular system, blood, lymphatic system, and bones are discussed. Clinical diagnosis of malignancy and benign tumors is also discussed. (R.V.J.)

Radiation Effects on Animals

Refer also to abstracts 4942 and 4984.

5006 (JPRS-44897) VESTNIK OF THE USSR ACADEMY OF SCIENCES, VOL. 37, NO. 12, 1967. Translation of Vestn. Akad. Nauk SSSR, 37: No. 12, 3-103(Dec. 1967). 119p. CFSTI.

Papers within the scope of NSA were abstracted from the original language and appeared in previous issues. (HGD)

5007 OSNOVY RADIATSIONNOI BIOLOGII I BIOKHIMII. (The Principles of Radiation Biology and Biochemistry). Lipkan, N. F. Kiev, Edorov'ya, 1968. 210p.

Properties of radioactive emissions, their biological effects, radiosensitivity of human and animal organisms, and their various tissues, organs, biological substances, and metabolic chains are discussed. Local and whole-body, external and internal, single and chronic radiation effects are evaluated. Detailed data are presented on radiation genetic effects, radiochemical processes in tissues, and basic proteo- and nucleic acid metabolic processes. Other metabolic processes are reviewed. Radiation effects on the activity of ferments, hormones, and vitamins in organisms are reviewed. Descriptions are included of various radioprotective substances, their classification and protective mechanisms. Tabulated data on toxicity, permissible doses of isotopes, and their retention in organisms are given. 200 references. (R.V.J.)

5008 PRIMENENIE PRINTSIPA POPADANIYA V RADIOBIOLOGII. (The Use of Hit Theory in Radiobiology). Timofeev-Resovskii, N. V.; Ivanov, V. I.; Korogodin, V. I. Moscow, Atomizdat, 1968. 228p.

A brief history is given of the use of the hit principle in radiobiology and its application to analysis of test data on biological effects of ionizing radiation is illustrated by several examples. The radiation effects considered are production of point mutations and chromosome breaks, inhibition of cellular fission, and destruction (or inactivation) of cells, recovery of cells from radiation injury, and some aspects of radiation pathology of multicelled organisms. The purpose of the book is to indicate the general value of the hit principle and its position in the analysis of experimental data from diverse sections of radiobiology. This principle is fruitful in the interpretation of not only experimental data, but also of complex radiobiological reactions. (tr-auth)

5009 OPOSREDOVANNOE DEISTVIE IONIZIRUYUSHCHEGO IZLUCHENIYA. (Environmental Effects of Ionizing Radiation). Sverdlov, A. G. Moscow, Atomizdat, 1968. 271p.

The environmental effect of penetrating radiation and its role in the development of radiation sickness and the environmental effects of radiation on the blood-producing organs and peripheral blood, chromosome apparatus and mitotic activity of the cell, exchange of nucleic acids, state of the fermentation system, and growth of tissues are considered. The mechanisms of delayed radiation effects, i.e., neuroendocrine reactions and effects of toxic agents, are examined. The participation of toxic products in changes of the morphological composition and blood coagulation, vascular tone, factors of natural immunity, genesis of chromosome mutations, and self-sensitization of the irradiated organism is analyzed. Data are presented on the nature and properties of radiotoxins. Methods of experimental radiation sickness are also described. (tr-auth)

Invertebrates

Refer also to abstracts 4555, 4905, and 5032.

5010 (ORNL-tr-1899) EFFECT OF GAMMA RADIATION ON WINTERING BEES. Pelerents, C. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Meded. Landbouwhogesch. Opzoekingssta. Staat Gent, 27: 896-907(1962). 14p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The effects of fractionated dose of ^{60}Co γ radiation at total doses ranging from 2,000 to 100,000 RAD on the behavior and survival of wintering honey bees were studied from the standpoint of possible stimulating or mutagenic effects. Doses above 40,000 RAD caused an immediate stimulus that resulted in the formation of clusters, used in natural circumstances only as a means of protection, temporary paralysis, or death for older bees exposed to the higher doses. The average food consumption and lifespan of all bees was reduced as a function of dose. Bees exposed to doses greater than 50,000 RAD did not build up wax or build cells and the construction of a queen cell was observed only in bees exposed to radiation doses below 10,000 RAD. (C.H.)

5011 (UCRL-Trans-10276) ACTION OF IONIZING RADIATIONS ON THE DEVELOPMENT OF PLANARIA. Benazzi, M. Translated by B. J. Hazzard for Univ. of California Lawrence Radiation Lab., Livermore, from Atti Accad. Sci. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 32: 26-9(1962). 11p. Dep. CFSTI.

Eggs and embryos of Dugesia lugubris were γ- and x-irradiated at various stages of development. Following irradiation embryos were removed from cocoons and examined microscopically. The stages most sensitive to radiation were recently fertilized eggs and embryos in early stages of development. Doses up to 1300 R did not prevent development to maturity. Doses of 1500 to 2000 R were lethal for eggs during the first hours after deposition. The same doses administered to embryos that had developed to the appearance of eyes and pharynx had no effect until after a few days when swelling, depigmentation, and disintegration occurred. Adults irradiated with doses of 3000 to 6000 R continued to feed and deposit cocoons for three to five weeks; lesions appeared after this interval. It is thought that the effects of radiation are brought about by destruction of neoblasts and that the animal does not show damage until the time at which repair of tissues by neoblasts becomes necessary. (H.L.W.)

5012 INVESTIGATION OF THE CAUSES OF RADIATION DISRUPTION OF THE PUPATION OF EPHESTIA KUEHNIELLA LARVAE. Yusifov, N. I.; Kolomiitseva, I. K.; Kuzin, A. M. (Inst. of Biological Physics, Pushchino, USSR). Radiobiologiya, 8: 510-13(1968). (In Russian).

The injection of 0.5 to 1 mg ecdysone into Ephestia kühniella larvae, irradiated at a dose of 30 kR 48 hrs before pupation, that had entirely lost their ability for pupation, produced signs of pupation in 50 to 60% of the cases. Irradiation of the larvae at a dose of 30 kR 24 hrs before pupation, i.e., during the phase of completion of ecdysone synthesis and its distribution through the body of the larva, had no influence upon subsequent pupation. The appearance of signs of pupation in the larvae when an ecdysone preparation was administered after irradiation was evidence of the relative radioresistance of the macromolecular systems controlling the process of synthesis of the pupation enzymes. (auth)

5013 A COMPARISON OF RADIATION PROFILES OF ACHETA DOMESTICUS AND TENEBRIO MOLITOR. Menhinick, Edward F.; Crossely, D. A. Jr. (Oak Ridge National Lab., Tenn.). Ann. Entomol. Soc. Amer., 61: 1359-65(Nov. 1968).

Radiation-induced mortality was investigated for developmental stages of house crickets, Acheta domesticus (L.), and yellow mealworms, Tenebrio molitor L. Insects were exposed to γ rays from a ^{60}Co source at rates of 3 or 30 kR per minute and given total exposures of 1 to 512 kR in 100% increments. Postirradiation temperature was 28°C. Effects were expressed as differences in mean and median life expectancy. In general there was a decline in radiosensitivity with age, although there were exceptions. Acheta was unusually radiosensitive, with life expectancy of all stages severely shortened by exposure to 4 kR. Tenebrio pupae and adults exhibited a survival plateau, with similar life expectancies following exposures from 8 to 32 or 64 kR. Some increase in life expectancy appeared following low exposure doses of radiation. (auth)

5014 PRELIMINARY STUDY ON THE BIOLOGICAL EFFECTS OF GAMMA RAY ON THE SILKWORM, BOMBYX MORI, L. Park, Kwang Eui; Hyun, Jai Sun (Seoul National Univ.). J. Nucl. Sci. (Seoul), 8: Pt. 2, 19-25(Aug. 1968). (In Korean).

Silkworms irradiated on the first day of the fifth instar showed increased body weights. At doses higher than 4,000 R the number of eggs produced by the ovary decreased. At doses higher than 2,000 R the number of eggs laid decreased. Hatching ratios were decreased by irradiation. The age at which the silkworms were irradiated had little effect on their biology. (H.L.W.)

Vertebrates

Refer also to abstracts 4548, 4557, 4565-4567, 4878, 4879, 4881, 4884, 4895, 4896, 4899, 4900, 5030, and 5032.

5015 SOME PECULIARITIES OF THE WEIGHT CHANGE OF GROWING ANIMALS AFTER A RADIATION INFLUENCE. Kholin, V. V. (Lenin Inst. for Advanced Training of Physicians, Leningrad). Radiobiologiya, 8: 519-22(1968). (In Russian).

Radiation influence within the dose range 50 to 200 R can lead to an increase in the body weight of growing animals in comparison with nonirradiated animals. The weight gain is accompanied by visible signs of stimulation of growth and maturation of rats. The probability of the appearance of this effect varies inversely with the age of the animal. The indicated phenomena were considered as signs of a unique radiation pathology of growing organisms and were arbitrarily denoted by the term false stimulation. The phenomena mentioned were the most substantial in cases of irradiation at a dose of 200 R. Irradiation of newborn rats at a dose of

50 R did not lead to sufficiently distinct and statistically significant indices of weight increase, accelerated growth, and maturation. In a histological study of the thymus gland and hematogenic organs, relatively weak morphological changes, expressed in damage of a small number of individual free cellular elements, were detected. Thus, a definite relationship between the effect of false stimulation and the injurious action of X rays upon cells of the growing organism was revealed in acute experiments. (JPRS)

5016 DIRECT AND MEDIATED INFLUENCE OF RADIATION ON THE TRANSMISSION OF EXCITATION IN THE UPPER CERVICAL SYMPATHETIC GANGLION OF THE CAT. Mtskhvetadze, A. V.; Kucherenko, T. M. (Central Scientific Research Roentgenoradiological Inst., Leningrad. First Leningrad Medical Inst.). Radiobiologiya, 8: 624-7(1968). (In Russian).

The functional structures of the vegetative nervous system that are influenced first by radiation were studied. The basic stages of synaptic transmission, including the mediator link and the functional state of the ganglionic cells within the range of various doses of the radiation influence (800 to 2500 rad), were investigated. The methods of Korsten were used to determine the amount of acetylcholine, and potentiometric titration was used to investigate the cholinesterase activity. Under the influence of local irradiation at a dose of 800 rad, during a period of 15 to 20 min after irradiation, an appreciable facilitation of the ganglionic transmission was noted, that may be associated with the participation of the sympathetic nervous system in the protective responses of the organism. However, within an interval of 60 to 70 min after irradiation, all the indices changed toward inhibition. At a dose of 2500 rad, as well as in the case of whole-body irradiation at a dose of 800 rad, inhibition was already noted in the 15 to 20 min period, with a progression of this phenomenon in the later period of the investigation. The bioelectric activity of the shielded ganglion changed negligibly. The cholinesterase activity decreased in all the experiments, while the amount of acetylcholine increased. (JPRS)

5017 BONE MARROW TRANSPLANTS. Ferrebee, Joseph W. (Mary Imogene Bassett Hospital, Copperstown, N. Y.). J. Arkansas Med. Soc., 64: 283-6(Jan. 1968).

Some relations between irradiation, bone marrow transplants, and leukemia are discussed. If a dog is exposed to 750 to 1500 R of whole-body x irradiation, the marrow becomes aplastic and the white cell count and platelet count fall to null levels in a few days. A slow return to normal hematopoiesis after eight weeks of supportive therapy was observed in dogs after exposure to 1400 R. A similar slow recovery was observed in patients exposed to somewhat lower doses of irradiation. Dogs that were exposed to 1000 to 1500 R and then given infusion of their own marrows had rapid, prompt restoration of normal hematologic and immunologic status and were rarely critically ill. The rates of return of peripheral white blood cell counts were comparable in dogs that were exposed to 1000 to 1500 R and then given either an infusion of previously stored autologous marrow or an infusion of previously stored autologous white cells collected from the peripheral blood. If white cells were used instead of marrow, about 10^{10} cells were required for a 10 Kg animal. If marrow was used, 10^{9} cells would suffice. However, to control leukemia something more was needed than just irradiation and the transplantation of histocompatible marrow. Studies in animals suggested that what was needed was implantation of marrow that was different from the patient's and was resistant to the leukemia virus. (BBB)

5018 QUANTITATIVE CHANGES IN THE CELLS OF THE HEMATOGENIC ORGANS UNDER THE INFLUENCE OF IONIZING RADIATION. Tarakhtii, E. A. (Inst. of Ecology of Plants and Animals, Sverdlovsk, USSR). Radiobiologiya, 8: 514-18(1968). (In Russian).

The change in the total number of nuclear cells was studied simultaneously in the spleen, lymph nodes, bone marrow of the femur, and in 1 ml^3 of peripheral blood of mice at various periods after a single whole-body γ irradiation at the dose $LD_{50/30}$. The tissues were arranged as follows according to degree of drop in the number of cells: spleen (ten-fold), bone marrow (30-fold), blood (42-fold), inguinal lymph node (90-fold), and mesenteric lymph node (180-fold). The periods of maximum drop in the number of cells also varied: on the fourth day in the spleen and bone marrow, on the eighth day in the inguinal lymph node, and on the 16th day in the mesenteric lymph node and in the peripheral blood. By the end of the observation period (32nd day), the number of cells in the spleen and bone marrow was entirely restored, while in the mesenteric lymph node it had reached 42% of the initial level and in the inguinal lymph node 16% of the initial level. The picture of the peripheral blood did not always reflect the state of the hematogenic tissues. The weight of the individual organs also decreased somewhat (four- to five-fold), and therefore the number of cells per unit tissue weight changed to a lesser degree. (JPRS)

5019 EFFECTS OF ADRENALIN, ACETYLCHOLINE, NICOTINE, PENTAMINE, AND HISTAMINE ON THE BLOOD PRESSURE OF RABBITS WITH EXPERIMENTALLY INDUCED HYPERCHOLINESTEREMIA AND AFTER THE INFLUENCE OF IONIZING RADIATION. Nikulin, A. A.; Krylov, Yu. F. (Ryazan Medical Inst., USSR). Radiobiologiya, 8: 618-21(1968). (In Russian).

The reactivity of the vascular system of rabbits (according to the blood pressure indices) toward adrenalin, acetylcholine, nicotine, pentamine, and histamine was investigated under conditions of experimental hypercholinesteremia, irradiation, and a combined injury (prolonged hypercholinesteremia, followed by irradiation at a dose of 300 R). (JPRS)

5020 INVESTIGATIONS OF THE CONNECTION BETWEEN VITAMIN E DEFICIENCY AND THE SELENIUM CONTENT IN ANIMAL ORGANS. Duftschmid, K. E. (Reaktor-Zentrum, Seibersdorf, Austria); Leibetseder, J. pp 353-63 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

Activation analysis was used to determine whether a deficiency of vitamin E alters the Se content of certain typical organs. For this purpose, 40 Cobb's one-day-old chicks were bred in batteries. One group was fed with vitamin-E-free standard diet; the other group was given the same diet but with an additive of 30 ppM of vitamin E. The Se content was 5 ppM in both cases. At an age of three weeks the chicks were killed and preparations of blood, plasma, cerebrum, cerebellum, pectoral muscle, liver, kidney, and gonads were taken. In order to assay the Se content of some 600 preparations in a reasonable time a fast method of analysis was chosen using the 17.5-s ^{77}Se. In this way the following advantages were obtained: the short half-life and high activation cross-section made possible a high sensitivity even after very short irradiation times (20 s); and problems arising from the matrix activity (mainly ^{24}Na) were minimized and a chemical separation was unnecessary. To eliminate the critical influence of the half-life, each sample was irradiated and measured simultaneously with a Se standard using a multichannel analyzer with an input facility for two detectors. Statistical evaluation of the measurements showed that the Se content of certain organs is influenced by the vitamin E supply. Thus, the muscle preparations from vitamin-E deficient animals contained significantly more Se than those from the control group, agreeing well with the known therapeutic success of Se applications in muscular dystrophy. Also, the gonads, known to be dependent on vitamin E, showed a high Se content, which for the ovary was a function of the vitamin E uptake. Further details of the Se-vitamin E mechanism are described. It was shown that the large number of analyses necessary for obtaining statistically well-founded results can be carried out in a reasonable time by the use of very short-lived radioisotopes. (auth)

5021 SRAVNITEL'NOE ISSLEDOVANIE LUCHEVOI BOLEZNI I EE POSLEDSTVII. (Comparative Studies of Radiation Sickness and Its After Effects). Yakovleva, L. A. Leningrad, Izdatel'stvo Meditsina Leningradskoe Otdelenie, 1966. 260p.

Materials on a comparative study of acute radiation sickness and its after-effects are presented. Monkeys, dogs, and small laboratory animals were employed in the study. Data obtained as a result of these experiments on animals are compared with those in the literature dealing with human radiation sickness. Character and causes of infectious after-effects of radiation sickness are discussed. Monograph is intended for radiologists and different physicians of a broad profile. (auth)

5022 LATE EFFECTS OF SUBLETHAL LEVELS OF RADIATION ON GROWTH AND NUTRIENT DIGESTION IN BURROS. Knapka, Joseph John. Knoxville, Tenn., Univ. of Tennessee, 1967. 92p.

Thesis.

Experiments were conducted to determine possible late effects of sublethal levels, 250 R, of whole-body γ radiation on growth of burro foals and on nutrient digestion in burros that had survived radiation for as long as 7 years. Groups of foals were randomly selected to be fed a ration containing either 9, 14, or 18% crude protein during a 364-day feedlot trial. Analysis of data indicated that radiation had no significant effect on any of the traits tested. There was a consistent though nonsignificant trend for irradiated foals to be less efficient in feed utilization than their nonirradiated counterparts. During the 152 days following the end of the

protein feeding trial, irradiated foals increased in height significantly more than nonirradiated foals. This difference cannot be explained on the basis of the present data. However, differences in gain of body weight and increase in heart girth were not significant. The results of the trials that involved irradiated burros indicated that there were no significant differences in the digestion as a result of irradiation. However, there was a consistent trend for irradiated burros to digest less crude fiber than nonirradiated burros. (Disser. Abstr.) (TSS)

5023 EXPERIMENTAL TRANSMISSION OF TWO CANINE NEOPLASMS: LYMPHOSARCOMA AND MAST CELL LEUKEMIA. Post, John Egbert. Ithaca, N. Y., Cornell Univ., 1968. 108p. Thesis.

The experimental transmission of canine lymphosarcoma and canine mast cell tumors was studied for the purpose of developing transmissible forms of these neoplasms and demonstrating in them the presence of etiological viral agents, if these existed. Tumor transplantation enhancement techniques included the use of newborn recipients, the use of pre-transplantation total body x irradiation, and the use of large transplantation doses of cells to induce immunological tolerance. Newborns proved to be less resistant than adults to the growth of the canine transmissible venereal tumor. Total body x irradiation of newborn pups with tissue dosages between 250R and 300R permitted 70% survival, but appeared to have little value in promoting successful transplantation. The induction of immunological tolerance by spleen cell homotransplantation permitted the survival of skin homografts for as long as three months. Using the technique of immunological tolerance in newborn pups, a canine lymphosarcoma was successfully passed by cellular inoculation through 2 generations of pups involving a total of 6 animals, all of which developed tumors. A third cellular passage and all cell-free passage attempts were unsuccessful. A canine mast cell leukemia was transmitted through 16 passage generations of newborn pups by cellular inoculation. It was also transmitted in 7 of these generations with cell free extracts, suggesting the presence of an oncogenic viral agent. Electron microscopic studies revealed a limited number of particles resembling the C-type viruses associated with the murine and avian leukemia. (Disser. Abstr.)

5024 STUDIES ON THE EFFECT OF X IRRADIATION ON METASTATIC LIVER CANCER IN RATS. Rikimaru, S. (Univ. of Kanazawa, Japan). Kanazawa Irigaku Sosho, 78: 1-31(Jan. 1967). (In Japanese).

To evaluate the effect of x irradiation on hepatic metastases, expansion of the cancer foci, and host survival, transfusions were made of AH-130 cancer cells into the portal veins of rats. Multiple metastatic liver cancer lesions resulted. Single doses (500 R) or fractional doses (up to 1500 R) of x irradiation were then delivered to the entire liver 3 days after transplantation. On the 7th day the animals were killed. Incidence of metastasis in each lobe of the liver was 94% in 14 control rats, but decreased to 88.8% in rats receiving 500 R and 79.5% in those given 1000 R. When the x-ray dose was increased, the percentage decreased. A total dose of 1500 R (500 R every other day, the 3rd, 5th, and 7th days after transplantation) resulted in a 4.9-day longer survival for 12 irradiated rats than for 12 control rats. A dose of 1500 R, given at the rate of 300 R every day from the 3rd day after transplantation, resulted in a lack of metastasis in 7 rats as compared with 1 rat of the control group. Irradiated rats survived 13.0 days, while control rats averaged 11.8 days survival. The minimal lethal x-ray dose for AH-130 cells was determined to be 3000 R for single in vitro irradiation. However, single doses of 1000 R or fractional doses of 1500 R, after cells had spread to liver tissue, permitted tumor cells to grow into large hepatic cancers. Histologic changes in the livers, considered to reflect radiation effects, included cloudy swelling of the hepatic cells 12 to 24 hr after 500-R doses, and partial fibrosis of the portal triad or thickening of interlobular artery walls about 3 weeks after 1500-R total doses. Single irradiation with 500 R caused only a transient decrease in mitotically active tumor cells. (BBB)

5025 INFLUENCE OF PYRIDOXIN ON THE CHOLESTEROL LEVEL IN THE BLOOD SERUM OF IRRADIATED RABBITS. Bogacheva, E. V.; Val'chuk, N. K. (Vinnitsa Medical Inst., USSR). Radiobiologiya, 8: 621-2(1968). (In Russian).

The influence of pyridoxin upon the change in the cholesterol content in the blood serum of irradiated animals was investigated (experiments on 40 rabbits). It was shown that the cholesterol level in the blood serum of irradiated rabbits was increased; the introduction of pyridoxin before irradiation retarded the increase in the cholesterol level in the blood serum, while after irradiation it promoted a more rapid normalization of the cholesterol content in the blood serum of the irradiated rabbits. (JPRS)

5026 GLUCONEOGENESIS IN VIVO FROM GLYCINE IN X-IRRADIATED RATS. Nadkarni, G. B.; Deshpande, Lalita D. (Bhabha Atomic Research Centre, Bombay). Int. J. Radiat. Biol., 14: 29-38(1968).

Gluconeogenesis in vivo from glycine-2-^{14}C was estimated in x irradiated (600 R) rats, by measuring the uptake of radioactivity in blood sugar and liver glycogen. The responses obtained were compared with those in cortisone- and insulin-treated animals. The incorporation of radioactivity in blood sugar and liver glycogen was high at all time-intervals studied in cortisone-treated rats, both in fasted and glucose-fed conditions, showing enhanced gluconeogenesis. Insulin-treated rats, on the other hand, presented an exactly converse picture, indicating reduced formation of new glucose from the ^{14}C-precursor. The effect of x-irradiation was different from that of either of these hormones. There was reduced ^{14}C incorporation in liver and muscle glycogen, while blood sugar showed an increased isotope uptake. Experiments with D-glucose-U-^{14}C did not indicate, however, any effect in respect of the turnover of glucose. These findings did not suggest an enhancement in the net synthesis of the sugar in x-irradiated rats, that could be correlated with the involvement of glucocorticoids. (auth)

5027 LACK OF RECRUITMENT OF ANTIBODY FORMING CELLS DURING THE LATE HAEMAGGLUTININ RESPONSE. Nettesheim, P; Hammons, A. S. (Oak Ridge National Lab., Tenn.). Nature (London), 220: 297-9(Oct. 19, 1968).

In studies of the effects of x-rays on late stages of the immune response, recruitment of new antibody cells from surviving and/or recovering immune progenitor cells could not be ruled out. Some studies with mice are described which were designed to eliminate this problem by (a) increasing the x-ray dose, (b) prolonging the x-ray effect by preirradiation thymectomy, and (c) studying a small population of antibody producing spleen cells cultured in cell impermeable diffusion chambers. Rat or sheep red blood cells were employed for immunization. Although the experiments did not completely rule out the possibility of a low rate recruitment of new antibody producers brought about by a small amount of persisting immunogen, they suggested that other factors are more important in maintaining high serum antibody levels for prolonged periods. The observations supported findings suggesting that foreign red blood cell antigens persist in immunogenic form and quantities only for a few weeks. The maintenance of antibody production and of immunological memory beyond this time appears therefore to depend on a population of long-lived cells being called into existence during the first few weeks of the immune response. (UK)

5028 OPEN-FIELD BEHAVIOR AND HEART RATE IN PRENATALLY X-IRRADIATED RATS. Furchtgott, Ernest; Tacker, R. Stephen; Draper, Douglas O. (Univ. of Tennessee, Knoxville). Teratology, 1: 201-6(May 1968).

Discrepancies in behavioral changes observed in animals, mainly rats, exposed to ionizing radiation prenatally are discussed, and attempts made to resolve some of them by studies in rats exposed to x radiation in utero on day 16 of gestation. In two separate experiments, animals that received 200 R, but not those that received 100 R, showed increased locomotor activity in an open-field on 3 successive daily 3-min test sessions. In contrast to this hyperactivity, exploration measured by the duration of sniffing at novel objects was lower in irradiated animals on the first test day, but reached the level of the controls on the second test day. Animals with previous testing experience did not show increased locomotor activity at the age of one year. Measures of defecation did not discriminate as reliably as did locomotor activity. Animals that received 200 R also had a higher heart rate than a control group, with the difference decreasing over a 60-min testing period. The results indicate that prenatally x-irradiated rats show fearfulness when exposed to novel situations but with increased exposure to the testing situation or experience the animals' responses tend to approximate those of unexposed animals. (BBB)

5029 PECULIARITIES OF HEMODYNAMICS IN PERSONS WORKING UNDER CONDITIONS OF EXTENDED ULTRAHIGH FREQUENCY ELECTROMAGNETIC RADIATION. Fofanov, P. N. (Scientific Research Lab., Leningrad). Klin. Med. (Moscow), 44: 18-22(Apr. 1966). (In Russian).

Hemodynamic changes were studied in 45 men, aged 20 to 39, with 1- to 14-yr employment records under working conditions exposing them to uhf electromagnetic radiation at doses of 10 to 170 $\mu W/cm^2$, 6 to 7 times a month up to 500 $\mu W/cm^2$ and 3 to 4 times up to 1500 $\mu W/cm^2$. The control group included 15 males of the same age who performed the same functions, but were not exposed to radiation. The tests on fasting subjects were performed in the morning, after a 45- to 60-min rest, by mechanical

cardiographic recordings, tacho-oscillography, and sphygmography, to provide the required data. The resultant tabulated data, when compared with the findings of the control group, showed a decreased systolic stroke volume, total cardiac output, and heart rate. It was found that the low systolic stroke volume induced, on the background of sinus bradycardia, a decreased minute volume. As a reaction to the decreased cardiac output, arterial tonus increased, with moderate stenosis of precapillary vessels, which resembled an adaptive reaction. Meanwhile, peripheral resistance increased to an extent resulting in decreased circulation of blood. It was concluded that these hemodynamic changes were caused by an impairment of the cardiovascular control system, with depression of sinoatrical node activity as a result of parasympathetic effects. As the duration of occupational exposure increased, the pulse and cardiac output decreased somewhat, while peripheral resistance increased. (BBB)

Man

Refer also to abstracts 4541, 4543, 4558, 4561–4564, 4568–4573, 4575, 4580, 4880, 4881, 4946, 4977, 4978, 4984, and 4986.

5030 (AD-671436) SOVIET RADIOBIOLOGY. Surveys of Foreign Scientific and Technical Literature. Fortunatow, E. (Library of Congress, Washington, D. C. Aerospace Technology Div.). June 10, 1968. 94p. (ATD-68-105-108-9). CFSTI.

Contents: Space oriented radiobiology; Genetic aspects of radiobiology; Radioprotective measures; Effects of radiation combined with other spaceflight factors; Non space-oriented radiobiology; Biological effects of magnetic, electromagnetic, and electric fields. (USGRDR)

5031 (AEC-tr-6966) HEMATOLOGICAL DISTURBANCES IN CHRONIC RADIATION EFFECT. Sokolov, V. V.; Gus'kova, A. K. Translated from Med. Radiol., 13: No. 5, 24-7(1968). 6p. Dep. CFSTI.

Changes in hematopoiesis in personnel chronically exposed to ionizing radiation in total doses from 150 to 400 R were examined by sampling of bone marrow cells and peripheral blood. Lower radiation doses resulted in relatively slight disturbances in hematopoiesis, whereas the larger doses caused a reduction in the content of hematopoietic cells of the bone marrow, a decrease in the number of thrombocytes and leukocytes in the peripheral blood, degenerative changes in mature cells, and an increase in the relative content of immature cells in peripheral blood. (C.H.)

5032 (TID-24310) LATE SOMATIC EFFECTS OF IONIZING RADIATION. Van Cleave, Charles D. (North Carolina Univ., Chapel Hill. School of Medicine). July 1968. 310p. Dep. CFSTI.

Manifestations of late effects in whole organisms are considered in the first part of the book. The following aspects of life shortening by ionizing radiation are discussed: life shortening by single doses, multiple doses, or protracted irradiation in rodents; influence of genetic factors; age effects; effects of partial-body exposures; negative life-shortening effects of radiation; and life shortening in man. One chapter is devoted to leukemogenesis in man and in mice. It is well established that leukemia occurs in man as a late somatic effect of radiation injury to the hematopoietic system received under a variety of exposure conditions. A chapter on radiation tumorigenesis in animals and man includes discussions of tumors of the skin, thyroid, bone, and lungs, cancer in atomic bomb survivors, and mechanisms of radiation carcinogenesis. Non-neoplastic late effects of radiation discussed are radiation cataract; effects on fertility; effects on the kidney; effects on antibody synthesis; degenerative changes; behavioral effects; and effects on growth and development. A chapter is devoted to effects of prenatal irradiation on man, mice, and rats. Although the radiosensitivity of the embryo is not greater than that of adult tissues, a minor irreversible injury in the embryo is amplified in the process of development. The second part of the book deals with manifestations of late effects in tissues, cells, and macromolecular assemblies. The third part of the book is concerned with degradative change and aging. Similarities and differences between the manifestations of late radiation effects and of natural aging are discussed in one chapter; biological organization and degradative change are discussed in another chapter. A subject index is included. (H.L.W.)

5033 RADIATION AND HEALTH. Mayneord, W. V. (Univ. of London). Guys Hosp. Rep., 115: 397-411(1966).

An assessment is made of radiation hazards. Concepts of the threshold dose and the maximum permissible dose are discussed. It is suggested that the physiological and medical basis of deductions on which these doses are based are often inadequate and that the consistency of the whole system of specified levels is to some extent illusory and even misleading to those who know little of its evolution. No correlation was found between cancer mortality (carcinoma of the breast, uterus, trachea, lung, bronchus, stomach, and leukemia) and, for example, the natural radioactivity of drinking waters of various districts in the United Kingdom. Quantitative estimates of risk are examined that were made from the survivors of the explosions of Hiroshima and Nagasaki, from patients irradiated for ankylosing spondylitis, and from children exposed to diagnostic irradiation in utero. After numerous simplifying assumptions, the conclusion is reached from the atomic bombing survivors that 1 RAD of whole-body radiation causes one to two cases of cancer/million population/yr, averaged over the first 13 yr after exposure. The spondylitic patient evidence leads to an estimate of 1.3 cases/Rad/million/yr, averaged over seven yr. The evidence from irradiation in utero indicates an effect per RAD on the fetus that is greater than that on adults or children by a factor of between two and 10. The data indicate that the total leukemia risk is about 20 cases/million persons/Rad. In the genetic field the results are very complex, and still greater uncertainties exist; but if it is assumed that 2.5% of the total effect is expressed in each generation, it can be established that, if 1 RAD were received by a parental population of one million persons, 1.9×10^3 genetic deaths would occur over the first 10 generations and 8.5×10^3 to infinity. This estimate for the first 10 generations is compared with 2.4×10^6 cases of mutations of this type expected to arise spontaneously. The irradiation of a population to 1 RAD may therefore increase the risk of visible genetic abnormality by about one such case among 750 arising from so-called natural causes. (BBB)

5034 COMBINED X-RAY AND RADIUM GAMMA-RAY THERAPY FOR CANCER OF THE LIP. Wooldridge, Wilfred E.; Lorenc, Ernest (Univ. of Missouri, Springfield). S. Med. J., 61: 612-17(June 1968).

Occurrence of radioinjury during the radiotherapy of lip carcinomas and its prevention by use of improved techniques, with reference to 109 cancers in 106 patients, were reported. After several years of experimentation the authors further perfected the techniques of Lamb and his co-workers, generally by lowering the tumor dose and shortening the treatment period. These advantages were achieved while maintaining an extremely high cure rate of basal and squamous cancers of the skin and, at the same time, encountering a low incidence of late radionecrosis. The squamous cancers of the lower lip reported here were all treated with combined superficial x rays and interstitial Ra during a nine-yr period, 1954 through 1962. An initial single exposure of 2000 R of x-ray (85 KV), or lesser amounts over large fields to allow for backscatter, was given. Immediately following this x-ray exposure, Ra needles were implanted and left in place for five days. The total tumor dose in this five-day period was 5500 to 6000 R. Most of the lip cancers were treated with two 27-mm, 2-mg Ra needles, each with an active length of 15 mm and a wall of 0.5 mm of platinum. This filtration permitted the passage only of γ rays. With lesions of increasing size, three or even four needles became necessary. The position of these needles in the lip was of special concern. Dosage calculations were based upon a needle located parallel to, and 1 cm from, the linear center of the adjacent needle. A lesser distance resulted in overirradiation with an increased likelihood of sclerosis or radionecrosis. The cure rate of the primary lesions was 100% in the patients followed. In 99 patients whose course was followed, were encountered six instances of late radionecrosis, an incidence of 6.06%. Two of these cases developed at one and two yr after treatment; the remainder between three and four yr. Two of these occurred after physical injury to the lip and two after indiscriminate exposure to the sun. Radionecroses occurred more frequently in the earlier patients of the series when the authors were perfecting the technique. As experience increased there was less difficulty as they became more aware of the urgent necessity of not crowding Ra needles in the lip tissue. As for the protection of the operators and of those preparing the Ra needles, the use of low-intensity needles was of distinct advantage when compared to the use of 5- and 10-mg Ra intersitial needles for shorter periods of treatment. Several physicians who had employed low-intensity needles for several years showed no radiodermatitis on their fingers. Likewise, in the authors' practice, all personnel scrupulously observed protective techniques and film badges recorded no more than small percentages of the maximal allowable exposures. (BBB)

5035 CATARACT SECONDARY TO MICROWAVE RADIATION. Kurz, George H.; Einaugler, Richard B. (Univ. of New York, N. Y.). Amer. J. Ophthalmol., 66: 866-9(Nov. 1968).

Bilateral subcapsular cataracts were removed from a 51-year-old man eight years after exposure to microwave radiation over a seven-year period. Histopathologic examination of the extracted lenses revealed prominent areas of degeneration at the posterior

pole containing globules of acid mucopolysaccharide and numerous, minute, birefringent needlelike structures. (auth)

5036 RADIATION RETINOPATHY. Chee, Percival H. Y. (Univ. of Miami, Florida). Amer. J. Ophthalmol., 66: 860-5(Nov. 1968).

Four cases of posterior fundus lesions following radiotherapy were presented. All typically had radiation around the orbital area with scatter into the globe posteriorly. A varying latent period then followed before a visual deficit was noted. The posterior fundus picture varied and could include papillitis, neovascularization, retinal pigment epithelial atrophy, exudates, and microaneurysms or telangiectases. Many of these changes simulate the picture of diabetic retinopathy. However, diabetic retinopathy normally does not have the extensive retinal pigment epithelial atrophy present in these cases. (auth)

5037 ENRICHED STABLE ISOTOPES OF CALCIUM FOR THE STUDY OF CALCIUM METABOLISM IN CHILDREN. Bethard, W. F.; Schmitt, R. A.; Olehy, D. A.; Kaplan, S. A.; Ling, S. M.; Smith, R. H.; Dalle Molle, E. (General Dynamics Corp., San Diego, Calif. Children's Hospital of Los Angeles). pp 533-44 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

Calcium metabolism was investigated in children having various bone diseases. Of the six stable calcium isotopes only two (^{46}Ca and ^{48}Ca) are amenable to quantification by thermal-neutron reactions. The product radioisotopes, namely, 4.5-d ^{47}Ca and 8.8-min ^{49}Ca, have major gamma photopeaks at 1.30 and 3.10 MeV, respectively. The natural abundance of ^{46}Ca (0.0033%), as well as its available enrichment (to 31%) and its limit of sensitivity (approximately 0.1 μg in this laboratory), make its use for tracer studies in children feasible. Calcium-48, with a natural abundance of 0.185%, an available enrichment of 95% and a sensitivity limit approximating 0.005 μg, can also be used. In the present series of experiments, ^{46}Ca was used because the longer physical half-life of its activation product, ^{47}Ca, permitted easier separation from 15-h ^{24}Na, that is also produced at the time of irradiation. Recent data indicate that fast-neutron reactions should also be considered in selecting a stable calcium isotope for in vivo studies. ^{42}Ca, ^{43}Ca, and ^{44}Ca undergo (n,p) reactions to produce 12.5-h ^{42}K, 22.4-h ^{43}K and 22-min ^{44}K respectively. The first reaction is not practical because of possible interference from $^{41}K(n,\gamma)^{42}K$, but either of the remaining two is potentially useful. Sensitivities are approximately 0.5 μg and 5.0 μg for ^{43}K and ^{44}K respectively, and the use of fast neutrons would minimize interference from ^{24}Na. Experiments were performed on children having various types of bone disease; and calculations of miscible calcium pool, bone formation rate, and bone resorption rate were made in accordance with the model proposed by Heaney and Whedon. Data are available for presentation in cases of hypophosphatemic, vitamin-D resistant rickets, and polyostotic fibrous dysplasia (McCune-Albright syndrome). (auth)

5038 NEUTRON ACTIVATION ANALYSIS FOR THE STUDY OF IODINE BALANCE IN MAN. Cottino, F. (Ospedale Mauriziano, Turin); Magro, G.; Malvano, R. pp 419-25 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

The determination of iodine in both the environment and the organism, as well as quantitative evaluation of the mutual interchange, are discussed. The usual chemical micromethods are not always entirely suitable, as difficult and delicate operations are sometimes required and interferences from foreign substances cannot always be excluded. Neutron activation analysis is therefore preferable because of its advantages of higher sensitivity, specificity, and precision. Activation techniques were adopted, often as a check on chemical methods, for investigations of iodine exchange, particularly in relation to some problems concerning endemic goiter. Drinking water was taken into consideration as a possible indicator of local iodine deficiencies, and foods and excreta were also analyzed. Moreover, the possibility and the utility of the iodine determination in biological fluids by activation analysis, as compared with chemical methods, is discussed. The adopted experimental techniques (irradiation conditions, chemical procedure) and some results are reported. (auth)

5039 ACTIVATION ANALYSIS FOR STUDYING BROMINE METABOLISM IN MAN. Sklavenitis, Helene; Comar, D. (CEA, Orsay, France). pp 435-44 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967. (In French).

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

Activation analysis was used to study the movement of bromine in the human organism and to determine the volume of extracellular liquid. Samples of total blood and blood plasma (sample size 0.5 cm^3) and of plasma proteins and urine (1 cm^3) were irradiated for 20 min or 24 h in a thermal neutron flux of 3×10^{12} n cm^{-2} s^{-1}. The radioisotope investigated was ^{82}Br formed by the $^{81}Br(n,\gamma)^{82}Br$ reaction. The bromine was separated from the biological samples in two different ways: in blood plasma and urine samples, simply by passing the sample over an ion-exchange resin (Dowex 2-X8); in total blood and protein samples, it was necessary to proceed to mineralization and extraction by CCl_4 and then to precipitate the bromine by silver nitrate. The chemical reaction yield was calculated by neutron activation of the AgBr precipitates. A surcharge of 1 g KBr per 50 kg of weight was administered orally to five normal subjects. Changes in the quantity of bromine in the total blood, the plasma, and the urine were followed over a period of 30 to 50 days. It was found that the biological half-life of bromine in the human organism varies from 10 to 12 days and that elimination is almost entirely in the urine. The volume of extracellular liquid in 45 subjects was calculated from the quantities of bromine in the plasma before, and 6 and 24 hr after administration of a surcharge of natural bromine. The results were compared with results obtained with ^{82}Br. The quantities of protein-bound bromine in the blood plasma of four subjects before and after administration of a surcharge of natural bromine were measured after precipitation of the proteins present in 1 cm^3 of plasma. Changes in the behavior of the protein-bound bromine were followed over a period of 40 days. (auth)

5040 MYCOSIS FUNGOIDES FOLLOWING APPLICATION OF THOROTRAST, WITH DEVELOPMENT TO RETICULAR CELL SARCOMATOSIS. Hundeiker, M.; Berger, H.; Petres, J. (Univ., Freiburg i. B.). Arch. Klin. Exp. Dermatol., 232: 56-65 (1968). (In German).

A case of mycosis fungoides (MF) is reported in a patient who died in 1966 at the age of 53, the MF being accompanied by reticular cell sarcomatosis. In view of the unknown etiology of the MF, this observation is of interest because a causal relation is considered to be likely between the appearance of the MF and prior administration of Thorotrast ($^{232}ThO_2$). Thorotrast had been used in 1936 for angiography of the carotid artery. Skin lesions of MF were first observed in 1948. Autopsy revealed reticular cell sarcomatosis established in skin tumors and lymph nodes besides typical lesions of the MF. Thorotrast was found to be deposited chiefly in the liver and spleen; the lymph nodes had been found to contain radioactive material several years previously. Although the MF did not develop precisely at sites where Thorotrast was deposited, it is suggested that the radioactive contrast medium had induced MF as well as the reticular cell sarcomatosis deriving from it. The ability of Thorotrast to induce sarcomas is well known. (BBB)

5041 THE THERAPY OF HEMORRHAGIC DIATHESES RESULTING FROM PANMYELOPATHY FOLLOWING TUMOR TREATMENT, BASED ON A PERSONAL CASE. Cseffalvay, T.; Klose, S.; Tuetzer, F. (Kreiskrankenhaus, Zwenkau/Leipzig, Ger.). Arch. Geschwulstforsch., 26: 209-15 (1965). (In German).

The course of aplastic disease in a patient previously treated for ovarian carcinoma by x irradiation is described. Regardless of dosage after cytostatic or radiological treatment there is the possibility of the appearance of a panmyelopathy, including aregenerative anhemolytic anemia, leukopenia, and thrombopenia with hemorrhages caused by secondary fibrinolysis. Intensive methods of treatment for these complications of irradiation are discussed. The case presented demonstrates generally the unsatisfactory results of therapy of fully developed panmyelopathy. (TSS) (BBB)

5042 BASOCELLULAR CARCINOMA OF THE FACE AND SCALP. A NEW REPARATIVE PROBLEM FOLLOWING RADIATION LESIONS. Neuman, Z. Minerva Chir., 22: 948-9(Sept. 15, 1967). (In Italian).

The occurrence of radiodermatitis, radionecrosis, and radioinduced basocellular carcinoma following radiotherapy for malignant and benign skin lesions of the face and scalp is discussed with reference to the author's experience in plastic surgical treatment of these conditions. Case histories are cited in detail for 4 patients developing these complications. An analysis is made of 85 cases of radiodermatitis, 44 occurring after radiotherapy for malignant conditions and 37 for benign lesions. Of the 44 patients, 2 (4.4%) developed epithiomatosis; in one case 12 yr and in the

second 23 yr postirratiation. Basal cell epithelioma appeared at the margins of the irradiated zone. In the second group, 13 patients, or 32.9%, presented cutaneous tumors after radiotherapy for benign conditions. Thus of a total of 85 irradiated subjects, 15 (17.7%) presented malignant degeneration in irradiated skin or scalp. The latent period varied from 5 to 46 yr, with a median of 25 yr. The pertinent literature is briefly reviewed. (TSS) (BBB)

5043 ACTIVATION ANALYSIS IN HUMAN BIOCHEMISTRY. Taylor, D. M. (Inst. of Cancer Research, Sutton, Eng.). pp 391-401 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

The major applications of activation analysis in human biochemistry were in the study of trace elements. Up to the present time the main emphasis was on the study of the concentrations of one or many elements, metallic and nonmetallic, in the blood, cerebrospinal fluid, urine, and teeth, as well as in tissues. The availability of techniques for the simultaneous determination of many elements in a single sample permits the use of activation analysis for the study of trace element patterns under normal and pathological conditions. Such studies may indicate disturbances of the metabolism of certain elements in a specific disease, for example the disturbances of copper and manganese metabolism in some forms of cirrhosis of the liver, or may suggest hitherto unsuspected interrelations between two or more trace elements. Enriched stable isotope preparations and neutron activation analysis can be used for the study of the kinetics of trace element metabolism. This procedure is potentially capable of wide application not only to trace elements but also proteins or other compounds labeled with a suitable stable isotope. The application of activation analysis together with chromatography, or other separation procedures, to the determination of elements in specific compounds has not yet been extensively applied in human biochemistry, although some studies on iodine-containing hormones were reported. Further development of this type of technique, and of others such as neutron activation of tissue sections, may well yield important information on the form in which certain elements occur and are located in tissues. (auth)

5044 FIRST TRIMESTER FETAL HAZARD FROM ^{131}I. J. Amer. Med. Ass., 206: 2326(Dec. 2, 1968).

In answer to a question concerning the hazards and management of a case in which ^{131}I was administered to a hyperthyroid woman about the time of conception, the postnatal diagnosis and treatment of hypothyroidism are outlined. It was also stated that thyroid development was probably not sufficient for it to accumulate the radioiodine. (C.O.)

5045 RADIOGENIC LUNG CANCER IN MAN: EXPOSURE-EFFECT RELATIONSHIP. Archer, Victor E. (National Center for Urban and Industrial Health, Salt Lake City, Utah); Lundin, Frank E. Jr. Environ. Res., 1: 370-83(Dec. 1967).

Comparisons are made of lung cancer data from 5 groups of miners exposed to a wide range of levels of air-borne radioactive particles. Partly because of variable quality of the data for the different groups, alternative estimates of lung cancer risk were used: incidence or mortality rates, ratio of observed to expected rates, and proportion of lung cancer to all deaths. These 3 criteria indicated that lung cancer in mining groups tends to be directly proportional to mean radiation exposure. On the assumption of linearity of this relation and absence of a dose-rate effect, it was estimated that 1 rad to the bronchial walls of 1 million persons produces about 1 lung cancer per year, and that the average integral dose required to produce 1 lung cancer is 1.3×10^5 g rad. An exposure 360 rad appears to double the lung cancer incidence characteristic of the general population. It is suggested that lung cancer rates coupled with accurate atmospheric measurements of Rn daughters obtained from major mining areas in the world may be useful in providing more precise data than now available on the lower end of the exposure-response curve. (BBB)

5046 HYPOTHYROIDISM AND ^{131}I THERAPY. Lowry, W. S. B. (Northern Ireland Radiotherapy Center, Belfast). Brit. Med. J., 1: 427-8(May 18, 1968).

In thyrotoxic patients treated with ^{131}I, ~30% develop hypothyroidism after 2 yr. Excessive radiation dosage was blamed, but possibly may have nothing to do with the increased incidence. Within 2 yr, ~30% of thyrotoxic patients treated with carbimazole reverted to the euthyroid state. If ^{131}I therapy was used in these cases, the thyroid gland was usually permanently damaged and hypothyroidism inevitably resulted. The problem, therefore, was found to be identification of this group of patients beforehand rather than trying to reduce the dose of ^{131}I. Although a correlation between high thyroid antibody titers and postirradiation hypothyroidism has yet to be shown, it would seem wise not to treat these cases with ^{131}I. Further clues may be provided by an examination of serum levels of long-acting thyroid stimulator. On the other hand, radiobiological studies indicate that, following irradiation, mitosis may be delayed. Latent cell damage and death may not be seen until long after irradiation, when the cell has subsequently entered one or more mitotic divisions. As time progresses the feedback stimulus of the failing thyroid gland induces the pituitary to release more thyroid-stimulating hormone. Under this stimulus further thyroid cells enter division and die. By this process, increasing hypothyroidism could cause increased cell destruction. The development of postirradiation hypothyroidism thus may be a continuing process, progressing at a rate of about 3%/yr. For rats, a dose of radiation which reduces thyroid function inevitably interferes with the reproductive integrity of the gland. The irregular distribution of iodine in the thyroid gland may also indicate that some cells receive sublethal damage and are capable of recovery. (BBB)

5047 LATE DAMAGE OF THE SCAPULAR PLEXUS AFTER X-RAY THERAPY. Cendrowski, Wojciech (Psychoneurologic Inst., Pruszkow, Poland). Neurol., Neurochir. Psychiat. Pol., 16: 89-91(Jan. 1966). (In Polish).

A 62-yr-old female patient, who at the age of 58 received 40 x-ray treatments (doses unavailable) for left mammary carcinoma complained of general muscular weakness and of numbness and atrophy of the left arm muscles. A persistent backache was centered at a level of the first thoracic vertebra, 4 cm from the spine, with induced pain in all left fingers. Numbness of the skin extended over the left elbow area, where frequent deep, sharp pains resembled an electric shock response. Radiographs revealed no changes in the caudal-cervical area and in the lung region, but electromyographic examination showed injuries of the lower part of scapular plexus. (TSS)

5048 RADIONECROSIS OF THE FEMUR AFTER X-RAY THERAPY. Floares, Gh.; Mihailescu, V. Rev. Med.-Chir. (Iasi), 69: 483-6(Apr.-June 1965). (In Rumanian).

Osteoradionecrosis may develop many years after radiotherapy with relatively high doses, and its induction seems to be influenced by local factors such as trauma, local inflammatory processes, and deficits in vascularization of the affected bone. A case history of osteoradionecrosis of the left femur is reported in a 61-yr-old patient with chronic osteomyelitis, initially diagnosed as osteosarcoma, and who was exposed to 2 series of x irradiations of 7800 R each, over 4 fields. Apart from the large radiation dose, an important role is attributed to the local inflammatory process that favored the onset of this severe complication and finally necessitated amputation of the leg from the middle of the thigh. (BBB)

5049 LATE CLINICAL AND LABORATORY MANIFESTATIONS OF THOROTRAST ADMINISTRATION IN CEREBRAL ARTERIOGRAPHY: A FOLLOW-UP STUDY OF THIRTY PATIENTS. Janower, Murray L.; Sidel, Victor W.; Baker, William H.; Fitzpatrick, David E. P.; Guarino, Frances I.; Flynn, M. Jean (Massachusetts General Hospital, Boston). New Engl. J. Med., 279: 186-9(July 25, 1968).

Thirty patients who received Thorotrast for cerebral arteriography from 1948 to 1952 were studied to determine the delayed effects of chronic low-dose internal-emitter radiation. Bromsulfalein retention ranged from 5 to 27% and alkaline phosphatase from 4.7 to 9.8 units in over half the patients. Most had a moderate relative increase in the albumin and a decrease in the globulin fraction on serum protein electrophoresis. Only 3 patients had completely normal liver-function tests. There were no radiation-related abnormal physical findings, no increase in tumor incidence, and no consistent changes in red-cell morphology. X-ray films of the extremities, spine, pelvis, skull, chest, and abdomen to demonstrate the distribution of Thorotrast showed abnormal density in the spleen and liver, and frequently in scattered lymph nodes about the porta hepatis. The spleen in most cases appeared small, dense, and reticulated. Whole-body counting showed the lowest body burden of Th to be 0.13, and the highest 2.5 g. Most patients had between 1 and 2 g. The relation between body burden, as determined by whole-body counting, and the amount of contrast substance administered was generally linear. Nine patients of 10 studied showed a moderately high percentage of chromosomal abnormalities, especially deletions, dicentrics and rings. The estimated rate of breaks ranged from one to 33 per cell. Polyploid cells were found in 2 cases. Total abnormal cells observed per 50 scored cells ranged from 1 to 20. (BBB)

Radiation Effects on Plants

Refer also to abstracts 4539–4541, 4544, 4548, 4550, 4553, 4554, 4908, 4909, 4912–4914, 4919, 4920, 4922, 4942, 5030, and 5032.

5050 ON THE ROLE OF THE DOSE RATE IN PREPLANTING γ-IRRADIATION OF POTATOES. Voropaev, Yu. V.; Lur'e, L. S.; Parfenov, V. T.; Serebrenikov, V. S. (All-Union Inst. of Electrification of Agriculture, Moscow. Inst. of Potato Raising, Moscow). Radiobiologiya, 8: 635-7(1968). (In Russian).

Data are cited from laboratory, greenhouse, and field experiments on the preplanting γ irradiation of potatoes of the Lorkh variety with four values of the dose rate — 60, 300, 600, and 1500 Rad/min. It was established that in the case of preplanting treatment of the tubers, the effects of γ irradiation on the growth and development of the potato depended upon the dose rate. This dependence was also influenced by the absolute value of the dose (stimulating or inhibiting), the calendar periods of irradiation, and the time elapsed between irradiation and planting. (JPRS)

5051 CONTRIBUTION TO THE INVESTIGATION OF THE PROTECTION OF LIVE ORGANISMS FOLLOWING THE ACTION OF IONIZING RADIATION. VI. ACTION OF PMAA PLANT HORMONE ON THE CROP OF SOYBEAN IRRADIATED WITH X-RAYS IN THE R_1 AND R_2. Steiner, Aleksa; Cerkovnikov, Eugen; Kirigin, Marinka (Inst. of Physics, Rijeka, Yugoslavia. Inst. of Chemistry and Biochemistry, Rijeka, Yugoslavia). Acta Pharm. Jugoslav., 17: 181-96(1967). (In Serbo-Croatian).

R_1 and R_2 generations of Szuerkebarat soybeans were planted in 1964 and subsequently x-irradiated in the first or first and second generation. The plants were watered either by pure water or water containing varying concentrations of PMAA plant hormone. Growth and inhibition effects were studied carefully and data are summarized in twelve comprehensive tables. An analysis of the results showed that in the case of the R_1 and R_2 generation irradiation, one can establish a combination of pure water and hormone-solution watering for which one achieves not only radiation protection but also increases the size of the crop. (JPRS)

5052 INVESTIGATIONS OF THE PROPAGATION OF PLANT POLLEN BY AN INDICATOR ACTIVATION METHOD. Fendrik, I.; Glubrecht, H. (Technische Hochschule, Hanover). pp 325-33 of Nuclear Activation Techniques in the Life Sciences. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Nuclear Activation Techniques in the Life Sciences, Amsterdam, Netherlands. See STI/PUB-155; CONF-670546.

The study of the propagation of plant pollen is of special interest in ecology and plant breeding. Generally, radioactive labeling cannot be applied for this purpose since radioactive contamination of the materials under investigation cannot be tolerated. Instead, labeling can be performed by the use of an indicator element that has a high cross-section for neutron activation. This substance is introduced into the plant under consideration. The flying pollen is caught by polyethylene foils by means of electrostatic attraction. The foils with the pollen are irradiated in a nuclear reactor with a suitable flux of thermal neutrons. The labeled pollen grains can be detected and counted by autoradiography or by direct measurement. The method proved satisfactory for pines and sugar beet. Indicator elements used for detection by neutron activation were manganese and dysprosium. (auth)

5053 STUDIES ON THE PRODUCTIVITIES OF SOME SOYBEAN LINES AFTER X RAYS AND THERMAL NEUTRON SEED IRRADIATIONS. Chang, Kwon Yawl; Bin, Yeoung Ho (Chinju Agricultural Coll., Chinju City, Korea). J. Nucl. Sci. (Seoul), 8: Pt. 2, 169-75(Aug. 1968). (In Korean).

In order to select higher yielding lines of the soybeans, the seed of progenies of R_3 generation were irradiated with thermal neutrons and x rays. The results obtained are summarized as follows: Stem length of the treated lines showed a decreasing trend compared with the control variety, but the significant differences disappeared between the lines from different varieties. Stem diameter and branch number per plant were somewhat increased compared with the control varieties except the variety Ulsan. From the results, lines 1–67, 1–68, 2–47, 3–69, 3–49, 3–36, 3–25, 3–72, 3–47, 3-M, were the higher yielding lines of the soybeans than the control lines. These lines with the control varieties should be used for the yield trial in the succeeding generations in the next year. (auth)

5054 INFLUENCE OF PRE-SOWING ^{60}Co γ IRRADIATION OF COTTON SEEDS ON THE CONTENT OF PHOSPHOLIPIDS. Musaeva, S. M. (Inst. of Zoology and Parasitology, Tashkent). Dokl. Akad. Nauk Uzb. SSR, No. 3, 52-3(1968). (In Russian).

The influence of radiation dose on the content of phospholipids in cotton seeds was studied with 108-F type cotton. Irradiation with ^{60}Co γ-rays at doses of 3 to 6 Ci with a power of 302/sec was carried out before sowing. Data obtained showed that 3 Ci dose accelerated the phospholipid production process 19.5% (153.1 mg per 50 dry weight of nucleole) as compared to the control ones, improved the physiological state of cells and the intracellular metabolism. Irradiation with 6 Ci reduced the general content of phospholipids indicating strong inhibition of the phospholipid production process. (R.V.J.)

5055 STUDIES ON THE FLOWER INITIATION IN PHARBITIS SEEDLINGS. III. INFLUENCES OF X-RAY IRRADIATION. Wada, Kiyomi (Shizuoka Univ., Japan). Bot. Mag. (Tokyo), 81: 251-8(May 25, 1968).

Acute γ-ray doses below 1300 R did not affect either the elongation or development of vegetative shoots of the Japanese morning glory, Pharbitis nil, but severely affected flower initiation when they were given shortly before and after a flower-inductive dark period. Similar experiments were carried out using x rays. When the seedlings of the Violet strain were exposed to a single moderate dose of x rays (<1000 R), the growth of seedlings was scarcely affected, but the initiation and development of flower primordia were inhibited. This inhibition was greatest when the radiation was given 0 to 72 hr after the end of a flower-inductive dark period. Low doses of x rays (50 to 150 R) promoted flower initiation to some extent, especially when applied before the dark period. X irradiation at different times caused various types of abnormal flower buds. The range within which various abnormal flowers were observed was much wider than that obtained by γ irradiation. On the whole, however, the experiments with x rays confirmed the results obtained by γ irradiation. (BBB)

5056 THE EFFECTS OF ULTRAVIOLET IRRADIATION ON A COCCOID BLUE-GREEN ALGA: SURVIVAL, PHOTOSYNTHESIS, AND PHOTOREACTIVIATION. Van Baalen, Chase (Univ. of Texas Marine Science Inst., Port Aransas). Plant Physiol., 43: 1689-95(Oct. 1968).

The effects of uv irradiation (254 mμ) on a coccoid blue-green alga Agmenellum quadruplicatum, Strain PR-6, were examined in terms of the survival curve and measurement of short time photosynthetic rates. From the study of survival evidence it was found that a strong photoreactivation centered near 430 mμ. Measurements of photosynthetic rate suggested that there was a correlation between decay of photosynthesis and survival after uv exposure. The uv induced decay in photosynthetic activity was reversed by the identical photoreactivation conditions that increased the survival level. The photosynthetic data are interpreted as demonstrating a photoreactivation of photosynthesis in blue-green algae. (auth)

5057 USE OF GAMMA RADIATION TO CONTROL ALGAE. Morton, Stephen D.; Derse, Philip H. (Wisconsin Alumni Research Foundation, Madison). Environ. Sci. Technol., 2: 1041-3(Nov. 1968).

Gamma radiation is one possible method of controlling objectionable growth of algae. As a first step in determining its feasibility, the bloom-forming blue-green algae, Anabaena, Aphanizomenon, and Microcystis, the green alga, Chlorella, and the diatom, Gomphrena, were irradiated with a cobalt-60 source. Viabilities as a function of radiation dosage decreased with increasing dosage, though usually not linearly. The dosage-viability results were not dependent on the concentration of algae irradiated up to about 200 mg. per liter and only slightly dependent on the algal species, in contrast to chemical treatments. For significant control of algal growth under ideal laboratory conditions, a dosage of about 100 to 150 krads is needed. The possible use of spent nuclear fuel from nuclear power plants in large scale applications is discussed. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 4921, 4942, and 5030.

5058 EFFECT OF X-RADIATION ON THE RIBOSOMES OF YEAST CELLS. Ghosh, Nandini (Saha Inst. of Nuclear Physics, Calcutta). Z. Naturforsch., 23b: 1277-8(Sept. 1968).

Following x-irradiation suspensions of Saccharomyces cerevisiae were centrifuged, washed with buffer solution, and shaken with glass beads. The cells were kept at a temperature of 4°C. Studies on the sedimentation pattern indicated that there was no early or late radiation damage to the ribosomes. In another series of experiments the irradiated cells were allowed to grow for 5 hrs at a temperature of 30°C; a gradual decrease in ribosomes occurred. It is suggested that this effect is correlated with a decreased nucleic acid synthesis. (H.L.W.)

5059 PHAGE INDUCTION BY ULTRAVIOLET RADIATION IN STRAINS OF ESCHERICHIA COLI POSSESSING AND LACKING DARK REPAIR CAPACITY. Takebe, Hiraku; Ichikawa, Haruko; Iwo, Kazuhiro; Kondo, Sohei (Osaka Univ.). Virology, 33: 638-47(Dec. 1967).

Prophage induction by uv irradiation in strains of E. coli possessing and lacking dark repair capacity was investigated. E. coli B and its uv-sensitive mutant B_{S-1} were lysogenized by temperate phage ϕ80. Relative prophage induction by uv in the two strains paralleled relative uv killing, suggesting that prophage induction in a uv-resistant strain was susceptible to dark repair. Photoreactivation of induction was observed in B_{S-1}(80), suggesting that the initial damage for uv induction of prophage in this very sensitive strain was due to pyrimidine dimers. No recovery of induction, however, was observed in B(80) when the uv-irradiated cells were held in phosphate buffer at 37° although there was recovery of cell survival (liquid holding recovery). The frequency of spontaneous induction was much greater in B_{S-1}(80) than in other strains and one of the highest yet observed in bacteria. Although increased sensitivity to uv killing in the logarithmic phase was usually seen in lysogenic strains, B_{S-1}(80) was not more sensitive to uv killing than logarithmic phase B_{S-1}. Cell division after uv irradiation and before lysis, permitting viable cells among the progeny, could account for the lack of extra sensitivity in B_{S-1}(80). (BBB)

Radiosterilization and Radiopreservation

Refer also to abstract 4797.

5060 (CONF-680713-1) PRESERVATION OF TROPICAL FOODSTUFFS BY IRRADIATION. Cuevas-Ruiz, Jose; Luse, R. A.; Graham, H. D. (Puerto Rico Nuclear Center, Mayaguez). [nd]. Contract AT(40-1)-1833. 6p. DTIE.

From 6th Annual Conference on Caribbean Food Crops, Port of Spain, Trinidad.

Processing bananas and mangos by exposure to controlled doses of γ radiation extended the storage life of the fruit by approximately one week, and the γ processing of plantains extended the storage life by nine days. Retardation of ripening was found to be dependent on the stage of maturity of the fruit at the time of irradiation. No adverse effects on wholesomeness of the fruits were observed. Expose to γ radiation at the doses used resulted control of pest populations on mangos. The combination of hot water and γ radiation processing of mangos resulted in a firmer texture for mangos than those irradiated only. (C.H.)

5061 (ORNL-IIC-11(Suppl.1)) RADIATION PASTEURIZATION OF FRUITS AND VEGETABLES: A BIBLIOGRAPHY. Supplement 1. McKinney, F. E. (Oak Ridge National Lab., Tenn.). Aug. 1968. Contract W-7405-eng-26. 17p. Dep. CFSTI.

A list of 111 references on the subject is given. An author and a subject index are included. (C.O.)

5062 VARIATION OF THE AROMA OF FRUIT JUICE BY IRRADIATION. Barrera, R.; Gasco, L.; de la Cruz, F. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 12: 117-34(Mar.-Apr. 1968). (In Spanish).

The effect of γ radiation on the aroma of the juices of apples and grapes is being studied. A bibliographic review is given of the work done up to the present under the international food irradiation program. The methods used for the concentration of the aromatic substances in fruit juices are described. The effect of radiation on apple juice has been detected only at doses above 300 kRads. The radiopreservation of grape juice does not appear feasible as doses below pasteurization cause a very disagreeable odor. The chemical analysis of the constituents of this odor alteration has not yet been accomplished. 58 references. (TSS) (J.S.R.)

5063 STUDIES ON THE PRESERVATION OF FRUITS. I. EFFECTS OF γ-RAY RADIATION ON THE CHEMICAL COMPONENTS OF STRAWBERRIES. Kim, Hyung Soo; Choi, Young Rack; Byun, Si Myung (Radiation Research Inst. in Agriculture, Seoul). J. Nucl. Sci. (Seoul), 8: Pt. 2, 147-54(Aug. 1968). (In Korean).

To promote maturity and preservation of strawberries irradiated with gamma rays, the changes in appearance, moisture content, acidity, pH, reducing sugar, nonreducing sugar, total pectin, protopectin, versene soluble pectin, and water soluble pectin were examined during storage. In order to ascertain the optimum dosage of γ-irradiation the dosage ranging 1×10^5 to 1×10^6 RAD were administered to unripe strawberries and 2×10^5 to 5×10^5 RAD on the ripe respectively, and they were kept at a temperature of 20 ± 2°C by packing with polyethylene film. It is possible for 3×10^5 to 4×10^5 RAD irradiation to prolong the shelf-life by 6 days for unripe, and 3×10^5 to 4×10^5 RAD by 8 days for ripe compared with the control. As the dosage of irradiation was increased and the storage period was prolonged, the moisture content increased, while the sugar content decreased in both the ripe strawberry and the unripe. The total pectin and protopectin contents were decreased in the ripe as well as in the unripe, while versene soluble pectin content was increased as dosage of irradiation was increased. (auth)

5064 THE AIR-ROUTE OF SPREAD OF PATHOGENIC BACTERIA IN THE OPERATING ROOM: CONTROL BY BACTERICIDAL ULTRAVIOLET RADIATION. Hart, Deryl (Duke Univ. Medical Center, Durham, N. C.). Rev. Surg., 23: 381-92(Nov.-Dec. 1966).

Use of uv radiation to control bacterial contamination of the operative field is reported. The original concept was that the wound and sterile field should be protected from floating bacteria by a barrier of high intensity radiation on and about these areas, using a protective covering over the tissues whenever exposure to the radiation was not required by the operative procedure. However, since the first installation the objective has been, in addition to maintaining this barrier, sanitation, approaching sterilization, of the air and exposed surfaces of the entire operating room. To accomplish this, the uv units have been increased in number, dispersed more widely, and kept operating continuously. By the use of specially designed equipment, the use of radiation was extended to sanitize (95 to over 99% of viable bacteria on exposed surfaces are killed) examining, treatment, and bedrooms and to protect exposed sterile operating room supplies. When spore-bearing cultures of anthrax and other highly pathogenic bacteria were sprayed into the air of a closed system, allowed to settle, and then irradiated with uv, the droplet nuclei became sterile within 1.06 sec of exposure to a sufficient intensity of radiation. (BBB)

5065 PROMOTION OF THE RESEARCH AND DEVELOPMENT ON FOOD IRRADIATIONS. Kagaku Gijutsucho Geppo, No. 136, 8-9(Dec. 1967). (In Japanese).

An ad hoc Committee of the AEC on Food Irradiations had made a study on the measures to promote research and development, and in July, 1967, submitted its report to the AEC. Based on this report, the AEC decided in September, 1967, to carry it out as a national program, with the purpose: prevention of the loss of foods, stabilization of food supplies, etc. The basic policy for this research and development, as determined by the AEC, is given in the objectives, activities, national system, expenditures, and evaluations. The report of the ad hoc Committee is also given briefly. (NSA of Japan)

5066 MECHANICAL PROPERTIES OF LYOPHILIZED AND GAMMA-RAY-STERILIZED BONE TISSUES. Tylman, Donat (Inst. of Histology, Warsaw). Chir. Narzadow. Ruchu Ortoped. Pol., 31: 229-34(1966). (In Polish).

Experiments were conducted on 5 series of bone graft materials, each series consisting of 6 samples, 12 × 1 cm, of full thickness tibial bone removed from a human cadaver. The 1st series was examined shortly after the bones' removal, and 2nd series after 24-hr at the temperature of solid carbon dioxide. The 4 other series were studied after more complete processing, i.e., freezing, lyophilization, and sterilization by γ rays (doses not stated) according to the Mohs scale. Lyophilized, γ-irradiated bone tissue demonstrated a high degree of hardness, also increased mechanical resilience upon being exposed to compressive stress, as compared with fresh bone tissue. However, after thawing and immersion in physiological salt solution for 24 hr, fully processed bone graft materials showed that their hardness had decreased slightly, but their resistance to deformation under bending stress increased 3-fold. Thus, their suitability for additional pregrafting processing with sharp instruments met the required standards. Tabulated data of the mechanical parameters analyzed and physical formulae for resiliency evaluation are given to provide more detailed information. (BBB)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 4523.

5067 TECHNIQUES OF MATERIALS PREPARATION AND HANDLING. Bunshah, R. F. (ed.). Techniques of Metals Research. Volume I, Part 2. New York, John Wiley and Sons, Inc., 1968. 848p. $27.50.

Processing and operational steps employed in the preparation of purified compounds for producing high-purity metals are discussed. Chemical reactions are employed in processes for obtaining metals in the metallic state from their compounds. Vacuum induction melting, vacuum arc melting, electroflux remelting, electron beam melting, annealing, distillation, casting, and zone refining, are discussed as techniques to consolidate and refine primary purified metals. Casting techniques are described and the capabilities of each process are evaluated. Principles of solidification important to single crystal growth are given. Techniques used to grow metal single crystals from the melt are described and a table is included designating the technique applicable to specific metals. Cutting, handling, and the perfection of melt-grown crystals are discussed. An extensive bibliography is included for each chapter. (J.C.W.)

5068 TECHNIQUES OF MATERIALS PREPARATION AND HANDLING. Bunshah, R. F. (ed.). Techniques of Metals Research. Volume I, Part 3. New York, John Wiley and Sons, Inc., 1968. 691p. $25.00.

Deposition processes for various applications include evaporation for deposition of thin films, thin film sputtering techniques, plating, coating, and chemical vapor deposition techniques. Common fabrication processes are discussed and the methods applicable to various metals are tabulated. Magnetic pulse metal-forming, high energy rate forging and impact extrusion, and explosive working techniques are presented. Joining, machining, and powder metallurgy techniques are applied and the processes described. An extensive bibliography is included for each chapter. (J.C.W.)

5069 TECHNIQUES OF MATERIALS PREPARATION AND HANDLING. Bunshah, R. F. (ed.). Techniques of Metals Research. Volume I, Part 1. New York, John Wiley and Sons, Inc., 1968. 419p. $16.95.

Environment control in research on metals is discussed for various uses of vacuum techniques. System design considerations, various types of vacuum hardware applications, leak-hunting, and precautions for proper operation of the systems are summarized. Theory and physical principle, technology of construction, measurement practices, applications, merits, and sources of errors are discussed for temperature measurement and control in metals research. Heating and quenching techniques and the heat treatment of metals are summarized. An extensive bibliography is included for each chapter. (J.C.W.)

Corrosion and Erosion

5070 REACTION OF CARBON MONOXIDE WITH A TANTALUM SURFACE HEATED ABOVE 2000°K. Scheer, Milton D.; Fine, Joseph (National Bureau of Standards, Washington, D. C.). Surface Sci., 12: 102-7(Sept. 1968).

A mass spectrometer and an electron beam were used to analyze the gaseous reactants and products of the CO–Ta reaction. Residual C was removed from the thin Ta foils, and then mass spectral scans were carried out on the reaction products formed at 2390°K and 0.1 to 20 × 10^{-7} torr. The only product observed was at m/e = 197 and is attributed to the TaO molecule. The rate of TaO vaporization is first order with respect to the CO pressure, and a plot of the ionization rate I (TaO^+) versus 1/T (2192 to 2536°K and 1.8 × 10^{-6} torr) yields an activation energy of 5.1 ± 0.1 eV. The carbon produced on the surface diffuses into the lattice. A simple mechanism is presented for accounting for the results. (D.L.C.)

Preparation and Fabrication

Refer also to abstracts 4764 and 5334.

5071 (KFK-736) INVESTIGATION OF THE MODIFICATION OF THE OCCURRENCE OF BRITTLE PHASES IN WELDED JOINTS BETWEEN DIFFERENT TYPES OF MATERIAL WELDED BY THE ELECTRON BEAM PROCEDURE. Scheibe, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). July 1968. 111p. (In German). Dep.

Electron beam butt welding on 0.5 mm thick sheets of the material combination CrNi 18 8–Inconel 600 has shown that it is possible to obtain practically any concentration pattern in the molten zone and especially large concentration jumps on the boundaries of the molten zone. The size of the concentration jump depends on the site of the collision point of the electron beam with respect to the butt joint. For uniform concentration pattern without significant variations as well as a uniform pattern at various material depths, the usual welding parameters are responsible. A rough formula for the optimum parameters is given. It is possible to so affect the mixing and conditions in the weld seam that congruently melting intermetallic phases are limited to a very narrow region of the weld seam and incongruently melting intermetallic phases are completely suppressed. On a number of material combinations, which could not previously be welded flawlessly because of the occurrence of these phases, bend angles over 180° could be obtained. On the few combinations whose bend angles <180°, bend angles >180° could be obtained in all cases by a 0.3-mm thick intermediate layer of V. The welds of these thin foils can be simplified by a method which makes it possible to carry out several weld seams simultaneously. First studies on the mixing ratio on material combinations up to 10 mm show that at this thickness, a favorable concentration pattern with respect to the occurrence of intermetallic phases can be produced. Especially favorable are the results on tubes. (tr-auth)

5072 METALLIC BUILDING MATERIALS AND TESTING ARRANGEMENTS FOR BUILDING MATERIALS. Schneemann, Klaus (Chemische Werke Huels AG, Marl, Ger.); Witt, Werner. VDI (Ver. Deut. Ing.) Z., 110: 1207-11(Sept. 1968). (In German).

A bibliographic review is presented of the progress made in the development of new metallic structural materials and of test installations for them. Materials with an iron base, nickel and cobalt alloys, copper alloys, casting alloys, light metals, tantalum, niobium, and zirconium are discussed. Reactor technology and laminated materials are also considered. (101 references.) (J.S.R.)

Properties Evaluations

Refer also to abstracts 4781 and 5466.

5073 (BMI-1853) INVESTIGATION OF THE INITIATION AND EXTENT OF DUCTILE PIPE RUPTURE. Quarterly Progress Report, July–September 1968. Eiber, Robert J.; Maxey, Willard A.; Duffy, Arthur R.; Atterbury, Thomas J. (Battelle Memorial Inst., Columbus, Ohio). Nov. 1, 1968. Contract W-7405-eng-92. 8p. Dep. CFSTI.

Pipe-rupture experiments are being conducted to define the sizes of defects for initiating fractures in PWR and BWR primary-coolant piping and to test analytical methods. The experiments are being conducted on 24- and 12.75-inch dia pipes of A 106B steel and Type 316 stainless steel. Of the analytical methods, the fracture-mechanics K_c approach is very sensitive to the plastic-zone correction term, while the flow-stress approach predicts critical through-wall and surface flow sizes from tensile-test results. Four full-scale experiments were completed, and the fracture results on the surface and penetration defects are discussed. (D.L.C.)

5074 (COO-1247-12) TRANSPORT AND DEFECT PROPERTIES OF THIN METALLIC WIRES. Progress Report No. 6. Bass, Jack (Michigan State Univ., East Lansing). Sept. 16, 1968. Contract AT(11-1)-1247. 10p. Dep. CFSTI.

ALUMINUM — Mattiessen's rule in, size-dependent diviations from
MOLYBDENUM — electric conductivity of quenched wires of
PLATINUM — electric conductivity of wires of, quenched in liquids
— electric conductivity of wires of, size effects in temperature dependence of
TUNGSTEN — electric conductivity of wires of, quenched in superfluid helium (D.L.C.)

5075 FATIGUE CRACK PROPAGATION: AN ANALYSIS. Tomkins, B. (United Kingdom Atomic Energy Authority, Springfields, Eng.). Phil. Mag., 18: 1041-66(Nov. 1968).

A simple theory is developed to assess quantitatively the mechanism of fatigue crack propagation in metals. The basic laws governing fatigue are derived theoretically for failure in both the high and low stress regions, and the material parameters controlling crack propagation are determined.. The theory is compared with that developed using linear fracture mechanics. (auth)

5076 FIZICHESKOE METALLOVEDENIE BERILLIYA. (Physical Science of Be Metal). Papipov, I. I.; Tikhinskii, G. F. Moscow, Atomizdat, 1968. 451p.

Methods for obtaining high purity Be, such as vacuum fusion, zone fusion, and distillation are described. The physical properties of the metal (electric, thermal, magnetic, elastic, internal friction, diffusion, etc.) are described in detail. Its crystalline structure, thermodynamic characteristics and the pecularities of crystallization are also given. Special attention is given to the effects of different factors, such as composition, structure, and heat treatments on the physical properties of Be. Data on the effects of neutron and alpha irradiation on the structure and the physicomechanical properties of the metal are tabulated. New methods for investigating Be are also described. These include electron microscopy, high-temperature roentgenography, point analysis, and electronography. (tr-auth)

5077 HIGH-STRENGTH ALLOYS IN THE SYSTEM Th–Al–Mo–V. Glazunov, S. G.; Chinenov, A. M.; Khorev, A. I.; Gruzdeva, L. A.; Martynova, M. M. Tsvetn. Metal., No. 8: 91-2(Aug. 1968). (In Russian).

Results have shown that alloys, close to the critical concentration, alloyed by two isomorphous β-stabilizers (Mo and V) possess a better combination of stability and ductility than alloys of analogous composition alloyed by only one β-stabilizer. Alloys of above critical concentration, which differ from alloys of below-critical concentration by having approximately 4% more V, have poorer mechanical properties. (tr-auth)

5078 LOW-TEMPERATURE INTERNAL FRICTION IN QUENCHED NIOBIUM. Stanley, M. W.; Szkopiak, Z. C. (Univ. of Surrey, London). J. Mater. Sci., 3: 610-16(Nov. 1968).

Internal friction measurements (at 1 cycle/sec) were carried out over the temperature range from 100 to 280°K on niobium specimens quenched to room temperature from 2350°C. Internal friction curves immediately after quenching exhibited irregular peaks which were practically removed by a 20 hr anneal at room temperature. On subsequent isochronal annealing, three well-defined peaks occurred at about 185, 200, and 220°K. The relaxation strength of the peaks increased with increasing annealing temperature up to about 140°C, remained practically constant between 140 and 220°C, and subsequently gradually decreased to negligibly low values at about 380°C. The variation of the damping spectrum, as a result of quenching and subsequent room temperature and isochronal annealing, indicated the presence of an excess of quenched-in vacancies in the material. Most of the vacancies were probably trapped at dislocations, at interstitial impurities, or in clusters. The 185, 200, and 220°K relaxation peaks developed by post-quench annealing were identified as β-peaks observed in cold-worked bcc transition metals. The relaxation mechanisms causing these peaks were shown to be vacancy clusters, which might also involve interstitial impurities. (auth)

5079 EFFECTS OF NITROGENATION ON HEAT-STRENGTH AND TEMPERATURE THRESHOLD OF BRITTLENESS OF Mo ALLOYS. Kogan, Ya. D.; Lakhtin, Yu. M.; Shashkov, D. P. (Moscow Automotive Transportation Inst.). Metalloved. Term. Obrab. Metal., No. 9, 20-6(Sept. 1968). (In Russian).

Nitrogenation in an ammonia environment at 1000°C for 1 hr increased by 70 to 100% the heat-strength of deformed and recrystallized Mo and its alloys at 1000 to 1400°C. An increase in the temperature of nitrogenation increased the temperature threshold of brittleness and the microhardness of grain boundaries is also increased. (tr-auth)

5080 THE TEMPERATURE RELATION TO HARDNESS OF W PRECIPITATED FROM PYRO-GAS PHASE. Tsvetaev, A. A.; Chuzhko, R. K.; Balakhovskii, O. A. (Inst. of Physical Chemistry, Moscow). Metalloved. Term. Obrab. Metal., No. 9, 18-20(Sept. 1968). (In Russian).

Precipitates obtained by the reduction of tungsten hexafluoride were found to have the same hardness as the monocrystal. It was established that the hardness of W depends on its purity. (tr-auth)

5081 THE MECHANICAL PROPERTIES OF W MELTED BY ARC FUSION AT 20 TO 1100°C. Kopetskin, Ch. V.; Panovko, V. M. (Inst. of Metallurgy, Moscow). Metalloved. Term. Obrab. Metal., No. 9, 15-18(Sept. 1968). (In Russian).

Studies were made on vacuum melted W of different purity in deformed and recrystallized states at 20 to 1100°C. Hardness, resistance, and the range of plasticity were established as a function of temperature. The results showed that the transition temperature of plasticity was almost equal at 100 to 150°C for recrystallized and deformed W. (tr-auth)

Structure and Phase Studies

5082 PRECIPITATION PROCESSES AFTER RAPID COOLING IN MOLYBDENUM SOLID SOLUTIONS CONTAINING 10 Wt. PERCENT Fe. Wachtel, Ernst; Gebhardt, Erich; Chakraborty, Amiya Kumar (Max-Planck-Institut fuer Metallforschung, Stuttgart. Institut fuer Metallkunde, Stuttgart. Institut fuer Sondermetalle, Stuttgart). Z. Metallk., 59: 875-8(Nov. 1968). (In German).

The precipitation behavior in molybdenum solid solutions after rapid cooling was investigated on an alloy containing 10 wt % Fe with the aid of measurements of electrical resistivity, hardness, and magnetic susceptibility in dependence on annealing time at an annealing temperature of 900°C. Parallel to this, electron transmission and diffraction investigations as well as x-ray investigations were carried out. It was found that after rapid cooling the iron atoms are not statistically distributed in the molybdenum solid solution (clustering). This contrasts to the state after rapid quenching in which a statistical distribution of the iron atoms is found. During annealing of the rapidly cooled specimen at 900°C, a lamellar precipitate is observed which originates at large-angle grain boundaries and does not show any preference in orientation; its growth is due to grain boundary diffusion. After longer annealing times, a needle-shaped second precipitate occurs in the matrix. This precipitate has a distinct orientation and is formed by volume diffusion. After sufficiently long annealing times, the two precipitates react with each other so as to form the stable equilibrium phase Mo_6Fe_7. (auth)

Radiation Effects

Refer also to abstracts 5787 and 6044.

5083 (AD–671807) NOTCH DUCTILITY PROPERTIES OF SM-1A REACTOR PRESSURE VESSEL FOLLOWING THE IN-PLACE ANNEALING OPERATION. Final Report. Potapovs, Uldis; Hawthorne, J. Russell; Serpan, Charles Z. Jr. (Naval Research Lab., Washington, D. C.). May 21, 1968. 31p. (NRL–6721). CFSTI.

The embrittlement condition of the Army SM-1A reactor pressure vessel, as modified by the recently completed in-place anneal, was assessed and an analysis was made of the reembrittlement behavior of the vessel steel with subsequent radiation service. Experimental results from the reactor surveillance program developed through one complete irradiation and annealing cycle are presented, together with a summary of experimental information on the annealing response of the vessel steel (A350-LF1, Mod.) from accelerated irradiation programs. These data indicate a 0°F maximum pressure vessel wall Charpy-V 30 ft-lb transition temperature after the in-place anneal versus a −80°F preservice transition temperature (based on the notch-ductility properties of a duplicate ring forging). The maximum Charpy-V 30 ft-lb transition temperature of the pressure vessel before the annealing operation was estimated at 190°F. A projection of postanneal pressure vessel lifetime in terms of neutron fluence >0.5 MeV was derived from spectra calculations and the experimentally predicted reirradiation response of the pressure vessel steel. The maximum permissible vessel wall fluence is estimated at 5.5×10^{19} n/sq cm > 0.5 MeV. This is comparable to 124.7 Megawatt years of reactor operation. (auth)

5084 (BNWL-SA–1876) EFFECTS OF IRRADIATION ON THE STRUCTURE AND PROPERTIES OF STAINLESS STEEL. Bement, A. L.; Brager, H. R.; Claudson, T. T.; Holmes, J. J.; Merckx, K. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 30, 1968. Contract AT(45-1)-1830. 43p. (CONF-680825–1). Dep. CFSTI.

From Fundamental Properties of Materials and Nuclear Fuel Assemblies, Schenectady, N. Y.

Three separate experimental and analytical methods are described for investigating the consequence of fast reactor neutron damage on the performance and reliability of mixed-oxide fuel elements clad with austenitic stainless steel. The first phase involves the examination and description of radiation-induced defect states, such as polyhedral voids and sessile loops, and the correlation of this damage with mechanical properties. The second phase involves model development, using theoretical models and finite-lattice computer calculations, to describe the mechanisms of void nucleation and growth and to develop a procedure for extrapolate volume swelling caused by these voids to end-of-life clad fluences. The third phase is a systems modeling of the fuel model, and provides a means for calculating stress and strain distributions, for testing the validity of creep and swelling models for both fuel and cladding, and for statistically assessing the reliability of full performance against a failure model. (24 references are included) (auth)

5085 VACANCY DISLOCATION LOOPS IN IRRADIATED AND ANNEALED TUNGSTEN. Rau, Robert C. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. Phil. Mag., 18: 1079-84(Nov. 1968).

Electron-diffraction contrast experiments were performed to characterize crystallographically the dislocation loops which form during 1100°C annealing of neutron-irradiated tungsten. These experiments show that the loops are essentially pure edge in orientation, lying on or near {111} habit planes and having a/2⟨111⟩ Burgers vectors. The loops surround platelets of condensed vacancies which are believed to represent the excess vacancy population remaining after annealing of interstitials. (auth)

5086 NOTCH DUCTILITY PROPERTIES OF SM-1A REACTOR PRESSURE VESSEL FOLLOWING THE IN-PLACE ANNEALING OPERATION. Potapovs, Uldis; Hawthorne, J. Russell; Serpan, Charles Z. Jr. (Naval Research Lab., Washington, D. C.). Nucl. Appl., 5: 389-409(Dec. 1968).

Embrittlement of the Army SM-1A reactor pressure vessel, as modified by the recently completed in-place anneal, was assessed, and an analysis made of its reembrittlement with subsequent radiation service. Results from a surveillance program conducted during one complete irradiation and annealing cycle are presented, together with a summary of experimental information on the annealing response of the vessel steel (A350-LF1, Mod.) from accelerated irradiation programs. These data indicate a 0°F maximum pressure vessel wall Charpy-V 30 ft-lb transition temperature after the in-place anneal versus a −80°F preservice transition temperature (based on the notch-ductility properties of a duplicate ring forging). The maximum Charpy-V 30 ft-lb transition temperature of the pressure vessel before the annealing operation was estimated at 190°F. A projection of postanneal pressure vessel lifetime in terms of neutron fluence >0.5 MeV was derived from spectra calculations and the experimentally predicted reirradiation response of the pressure vessel steel. The maximum permissible vessel wall fluence is estimated at 5.5×10^{19} n/cm^2 > 0.5 MeV. This is comparable to 124.7 Megawatt years of reactor operation. (auth)

Ceramics and Cermets

Preparation and Fabrication

Refer also to abstract 4768.

5087 (AAEC/TM-464) SINTERING AND CRYSTALLITE GROWTH IN THORIA GEL. Bannister, M. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). July 1968. 33p. (CONF-680820-1). Dep.

From 3rd Ceramic Conference, New South Wales, Australia.

Studies on the sintering and crystallite growth phenomena in thoria gels are described. This work includes characterization of the gel by electron microscopy, thermogravimetric analysis and differential thermal analysis, crystallite growth studies using both x-ray line broadening and quantitative electron microscopy, measurement of specific surface changes during sintering, and the use of both isothermal and non-isothermal techniques to study the shrinkage behavior of the gel. The expulsion of volatiles from the gel causes significant shrinkages below 600°C. Above 600°C, shrinkage is accompanied by crystallite growth and a decrease in specific surface. The behavior observed in both of these temperature regions is described in detail and interpreted in terms of specific volatilization or material-transport mechanisms. (auth)

Properties Evaluations

Refer also to abstracts 4604 and 4781.

5088 (EIR-138) ANALYSIS OF A STUDY OF SUBMICRON POWDERED MEDIA RELATIVE TO THEIR USE AS THERMAL INSULATORS OF PRESSURE TUBES IN A NUCLEAR REACTOR. SiO_2 POWDERS AND POWDER-FIBER MIXTURES. Dorra, L. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Aug. 1968. 125p. (In French). Dep.

The various factors affecting the thermal conductivity of powdered materials are reviewed. Effects of choice of material are analyzed, and data on gases produced by heating SiO_2 fiber-powder mixtures are tabulated. Advantages and disadvantages of materials density factors are tabulated. Radiation effects on the thermal conductivity of powdered materials are summarized. (222 references) (M.L.S.)

5089 PROPERTIES OF SODIUM–LITHIUM NIOBATE SOLID SOLUTION CERAMICS WITH SMALL LITHIUM CONCENTRATIONS. Nitta, Tsuneharu (Matsushita Electric Industrial Co., Ltd., Osaka). J. Amer. Ceram. Soc., 51: 626-9(Nov. 21, 1968).

The structural, dielectric, and piezoelectric properties of the solid solution $(Na_{1-x}Li_x)NbO_3$ were studied. Solid solution ceramics with x values up to 0.14 occur as a single phase. The phase diagram from 0 to 600°C is given. The low-temperature phase has a perovskite pseudomonoclinic structure and inverts to a pseudotetragonal structure at a temperature that decreases with increasing x. The high-temperature phase is pseudocubic, and the minimum transition temperature from the pseudotetragonal to the pseudocubic structure is 350°C near x = 0.04. Anomalies in the dielectric constant vs temperature curve agree well with the transition temperatures, although no anomaly was observed at the temperature of transiton from the pseudotetragonal to the pseudocubic phase when x was less than 0.06. Lithium ions in the system facilitate the transformation from the antiferroelectric to the ferroelectric state produced by applying an electric field. A new ferroelectric phase becomes stable when x is greater than 0.07. Poled ferroelectric specimens had a planar coupling coefficient of 0.232, a dielectric constant of 220, and a frequency constant of 3352 kc-mm. The piezoelectric properties disappear not at the transition temperature but at the temperature at which strain exhibits an anomaly when x is greater than 0.07. A perovskite phase with a pseudorhombohedral subcell exists as an intermediate phase for x greater than 0.10, the exact value depending on the preparation method. The phase can be easily converted to pseudomonoclinic when the ceramic is fired at 1180 to 1220°C. (auth)

Structure and Phase Studies

5090 ROLE OF CERTAIN IMPURITIES IN HEATS OF TRANSITION OF $PbZrO_3$. Tennery, Victor J.; Hang, Kenneth W. (Univ. of Illinois, Urbana). J. Amer. Ceram. Soc. 51: 668-9 (Nov. 21, 1968).

The enthalpy changes in the orthorhombic → rhombohedral → cubic phase transition were measured for four $PbZrO_3$ samples with known impurity contents. It was found that increasing Ca content increases ΔH_t for the cubic → rhombohedral transition and decreases it for the rhombohedral → orthorhombic transition; the combined enthalpy changes are essentially independent of the impurity content. The highest Ca content (255 ppM) prevented the rhombohedral phase from appearing. The effects of Ca + Ti are compared to these of Ca alone. (D.L.C.)

Radiation Effects

Refer to abstract 6021.

Plastics and Other Materials

Refer also to abstracts 5447 and 6043.

5091 (EUR-4036) THE MEASUREMENT OF WIGNER ENERGIES ON SOME GRAPHITES WITH A CALORIMETER. Kemeny, G.; Rother, H.; von Birgelen, G. (European Atomic Energy Community, Petten (Netherlands). Joint Nuclear Research Center). Apr. 19, 1968. 18p. (In German). Dep.

For comparison, the stored Wigner energies of several types of graphite (two reactor graphites, pyrographite, and two vitreous types of carbon) were measured by a direct calorimetric method. The main calorimeter characteristic is a constant heat flux with the additional condition of a constant temperature rise. The measurements covered the temperature range of 80 to 500°C. The graphites had been irradiated at 40 to 70°C and 350 to 400°C up to an integrated dose of 6×10^{20} nvt. The maximum liberated energy fluctuated between 1.6 and 2.5 kJ/°kg according to the type of graphite. (auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstract 5403.

5092 ELLIPTIC POLARIZATION OF SYNCHROTRON RADIATION. **Legg, M. P. C.; Westfold, K. C. (Monash Univ., Victoria, Australia). Astrophys. J., 154: 499-514(Nov. 1968).**

Earlier calculations on the polarization characteristics of a distribution of ultrarelativistically gyrating electrons emitting synchrotron radiation were extended to the next order of approximation, and appropriate corrections made for the fundamental frequency at a field point. Calculations by Roberts and Komesaroff of the degree of circular polarization were corrected, and comparisons made with observations, particularly of the Crab Nebula. Here it appears possible that recent 38-Mc observations are consistent with the results obtained and a magnetic field of magnitude 10^{-4} gauss; further calculations are necessary before valid comparisons can be made with recently reported optical measurements. (auth)

5093 NUMERICAL INTEGRATIONS OF THE N-BODY PROBLEM. Van Albada, T. S. (Groningen State Univ., Netherlands). Bull. Astron. Inst. Neth., 19: 479-99(June 1968).

A numerical integration was performed of the equations of motion of the N-body problem in order to obtain the characteristics of the dynamical evolution of a large number of N-body systems, with N = 10 and 24 and various mass spectra. It appears that a random configuration of stars in space, with an isotropic velocity distribution, obeying the virial theorem, is very unstable; in a time interval ranging from 5 to 50 times the characteristic time scale of the system, the group disintegrates. Groups with a large range in masses disintegrate much faster than groups with stars of equal mass. A more or less stable multiple system dominated by a massive close binary remains, containing about 5 stars for N = 10, and 8 for N = 24. The binding energy of this binary is about one and a half times the total (negative) energy of the group. For 30% of the groups considered the remaining system contains a massive triple star, with a hierarchical structure. For 5 to 10% of the groups there is a quadruple system, consisting of two binaries, one of them containing almost all the binding energy. The other stars in the remaining system are stars of small mass moving about the nucleus in extended orbits of rather low angular momentum. (IAA)

5094 VOPROSY ASTROFIZIKA. (Problems of Astrophysics). Bogorodskii, A. F. (ed.). Seriya Astronomiya i Astrofizika. Kiev, Izdatel'stvo Naukova Dumka, 1966. 208p.

Seventeen articles are included on the problems of astrophysics. The first 13 articles are devoted to: resonance scattering of solar emission in perturbations, spectrophotometric studies of perturbations, hydrogen excitation in perturbation expulsion, calcium glow in large chromosphere bursts, and dissipation effects on plasma equilibrium in magnetic fields. Models of preburst plasma state, convective model of stars with smooth rotation, alternating stars in M92, and the influence of the Earth's atmospheric turbulence on penetration power of telescopes are discussed in the last few articles. (R.V.J.)

5095 NONLINEAR WAVES WITH A MAGNETIC FIELD IN COSMIC PLASMA. Gintsburg, M. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 484-8(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 610-15(May-June 1968).

A solution is obtained for the equations of two-fluid magnetohydrodynamics in the form of periodic, large-amplitude ion waves. The magnetic-field vector is simultaneously subject to rotation and to change in magnitude. Analytic formulas for the wave profile are derived. Experimental evidence indicates that the interplanetary field is characterized by oblique nonlinear waves of this type. A new mechanism is proposed for the penetration of plasma into the magnetic transition layer and the magnetosphere: a drift resulting from the nonlinearity of these waves. Nonlinear ion waves with relativistic velocities are also considered; they would provide a new mechanism for generating cosmic rays. As an illustration, the acceleration of cosmic rays under the conditions prevailing in a solar chromospheric flare is evaluated. (auth)

Cosmic Ray Exposure Ages

Refer to abstract 5464.

Stars

Refer also to abstracts 5209, 5784, 5788, and 5934.

5096 ROCKET OBSERVATIONS OF ORION STARS WITH AN ALL-REFLECTIVE ULTRAVIOLET SPECTROGRAPH. **Morton, Donald C.; Jenkins, Edward B.; Bohlin, Ralph (Princeton Univ. Observatory, N. J.). Astrophys. J., 154: 661-76(Nov. 1968).**

On September 20, 1966, an all-reflective objective spectrograph on an Aerobee rocket photographed the far-ultraviolet spectra of ten O and B stars in the vicinity of ϵ Orionis. Wavelengths from 1100 to 2750 Å were recorded with about 1 Å resolution. This paper describes the method of determining absolute wavelengths by using the zero-order images and presents the results for 283 lines measured in the spectra of the O and B stars γ, δ, ϵ, ζ, η, $\theta^1 + \theta^2$, ι, and σ Orionis. The interstellar Lyman-α absorption line was observed in δ, ϵ, ζ, η, ι, and σ Ori, but the presence of other interstellar lines is less certain. There seem to be C(I) lines in δ, ϵ, and ζ, and lines of O(I), Al(II), and Si(III) also may be present in some of these spectra. In the bright giant δ Ori and the supergiants ϵ and ζ Ori, the ultraviolet resonance lines of C(IV), N(V), Si(III), and Si(IV), as well as a C(III) multiplet from 6.5 eV excitation, are present in absorption, shifted shortward of their laboratory wavelengths with velocities up to 1800 km sec^{-1}, thus showing that these stars are ejecting mass. The C(IV) and Si(IV) lines have emission components at their long-wavelength edges in all three stars. The C(III), N(V), and Si(III) lines also are found in ι Ori, and perhaps the N(V) line in γ Ori, again with shifts up to 1600 km sec^{-1}. Both of these stars are giants. Little or no shift was found for the Si(IV) and C(IV) lines in the main-sequence stars η and σ Ori. Many of the remaining lines originate from ions of the more abundant elements in the photospheres, but at least 100 features are still unidentified. (auth)

5097 STELLAR SPECTRA FROM 2.8 TO 14 MICRONS. **Gillett, F. C. (Univ. of California, San Diego); Low, F. J.; Stein, W. A. Astrophys. J., 154: 677-87(Nov. 1968).**

An infrared spectrometer was constructed for wavelengths between 2.8 and 14 μ with a resolution $\Delta\lambda/\lambda \approx 0.02$. The results of observations of the spectra of seven stars are discussed. The most pronounced features of these spectra are (1) a broad absorption feature around $\lambda = 5\ \mu$ in the spectra of α Ori, α Her, α Boo, and μ Cep and (2) a broad absorption feature near $\lambda \approx 8\ \mu$ and/or a broad emission peak near $\lambda \approx 10\ \mu$ in the spectra of α Ori, μ Cep, o Cet, and χ Cyg. By means of an absolute-calibration procedure, the data are plotted on an absolute flux scale referred to outside the atmosphere of the Earth. (auth)

5098 RADIATIVE OPACITY IN STELLAR ATMOSPHERES. I. METAL ABSORPTION COEFFICIENTS. **Travis, Larry D.; Matsushima, Satoshi (Pennsylvania State Univ., University Park). Astrophys. J., 154: 689-714(Nov. 1968).**

The results of numerical computations of the atomic absorption coefficients due to the elements C, N, O, Na, Mg, Al, Si, Cr, Fe, and Ni are presented. The quantum defect method is used for the determination of the photo-ionization cross sections except in the cases of Cr, Fe, and Ni. For these metals, detailed hydrogenic approximations are used owing to the inapplicability of the quantum defect method when LS coupling is not valid. These cross sections are used to compute the atomic absorption coefficients for temperatures ranging from $\theta = 1.38$ to $\theta = 0.36$, with an interval of $\Delta\theta = 0.06$, and a range in wavelengths of $\lambda\lambda 1033$ to 59958. The random errors involved in the empirical determination of the quantum defect are found to be comparable to the accuracy of the computed cross sections estimated from comparisons with experimentally determined values. Finally, the relative importance of metal absorptions in radiative opacity is examined for the atmospheric conditions of the solar-type and other spectral classes. (auth)

5099 RADIATIVE OPACITY IN STELLAR ATMOSPHERES. II. EFFECT OF ULTRAVIOLET CONTINUUM ON THE PHOTOSPHERIC RADIATION FIELD. **Matsushima, Satoshi (Pennsylvania State Univ., University Park). Astrophys. J., 154: 715-27(Nov. 1968).**

Comparisons with observations are made for theoretical limb darkening as well as for intensity distribution as a function of wavelength obtained from various solar models with different choices of opacities. Particular attention is directed to the opacity due to metals, using the photo-ionization cross sections recently computed by means of the quantum-defect method. It is found that satisfactory agreement can be obtained between theory

and observations if one assumes an additional opacity, amounting to a factor of about 10 to 100 larger than metal absorption in the spectral region between λλ2500 and 3500. The notable improvements in agreement with observations for the visual and infrared regions is attributed to a considerable change in the temperature stratification throughout the atmosphere produced by the ultraviolet flux, as a direct consequence of the condition of radiative equilibrium. Various evidences are presented to support the conclusion that the necessary opacity is due not to line blanketing but to the existence of a still unknown source of absorption, unless the errors involved in the determinations of metal absorption are unrealistically large. (auth)

5100 SPECTROPHOTOMETRIC STUDIES OF GASEOUS NEGULAE. XI. THE PLANETARY NGC 6543. **Czyzak, S. J. (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware. Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio); Aller, L. H.; Kaler, J. H. Astrophys. J., 154: 543-55 (Nov. 1968).**

By means of photographic and photoelectric techniques, the emission-line intensities in the spectrum between λλ3187 and 5175 of the planetary NGC 6543, which is an irregular object of excitation class 5, were measured. This object shows a range of excitation from Mg(I) to N(III) as well as a number of forbidden transitions involving ions from [O(II)] to [K(IV)]. The determination of the electron density and temperature by methods involving forbidden lines yields $T_e \sim 8200°K$ and $N_e \sim 5.6 \times 10^3$ electrons cm^{-3}. The latter value is also confirmed by surface-brightness measurements. (auth)

5101 ELECTRON CONDUCTION IN RED GIANTS. **Iben, Icko Jr. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 154: 557-79 (Nov. 1968).**

In the core of a low-mass red giant, the primary modes of energy flow are electron conduction and radiative transfer, limited by free–free absorption. An approximation to the electron conductivity is derived under the assumption that ion centers scatter independently via a shielded Debye–Hückel potential. This approximation is compared with the cutoff approximation to conductivity explored earlier by Marshak, Mestel, and Lee. The uncertainty in the properties of the red-giant core due to the uncertainty in the electron conductivity is examined and found to be encouragingly small. (auth)

5102 LOW-MASS RED GIANTS. **Iben, Icko Jr. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 154: 581-95 (Nov. 1968).**

The dependence of limiting helium-core mass, M_{core} (= core mass at the red-giant tip), on total stellar mass and on initial composition is discussed on the basis of calculated evolutionary models characterized by (M_{star}, Y, Z) = ($0.7\ M_\odot$, 0.35, 2×10^{-4}), ($1.3\ M_\odot$, 0.0, 2×10^{-4}), and ($1.25\ M_\odot$, 0.27, 0.02). Extremely rough estimates give $dM_{core}/dM_{star} \sim -0.06$, $dM_{core}/dY \sim -0.4\ M_\odot$ and $dM_{core}/d \log Z \sim 0.01\ M_\odot$. If the $^{14}N \rightarrow {}^{18}O$ reactions initiate the helium flash, then M_{core} is $\sim 0.08\ M_\odot$ smaller than if the 3-α reactions initiate the flash. The inclusion of postulated neutrino losses increases M_{core} by $\sim 0.03\ M_\odot$. (auth)

5103 DYNAMICAL STABILITY IN PRE-MAIN-SEQUENCE STARS. **Upton, E. K. L.; Little, S. J.; Dworetsky, M. M. (Univ. of California, Los Angeles). Astrophys. J., 154: 597-611 (Nov. 1968).**

Properties of adiabatic stellar models were calculated for a pure hydrogen composition over a wide range of temperatures and densities from degenerate to nearly interstellar conditions. The mass range covered was 10^{-4} to $10^2\ M_\odot$. Examination of the energies and entropies shows that some of the models are dynamically unstable and others are energetically inaccessible to a contracting body. Together the unstable and inaccessible models make up a collapse domain extending from approximately 1600 to 10^5 °K for stellar objects. The collapse domain narrows for smaller masses and seems to disappear near $10^{-4}\ M_\odot$. A contracting body must undergo rapid collapse when crossing the collapse domain, as was pointed out earlier by Cameron. In fact, collapse is probably brought about by Gaustad's mechanisms (low opacity) before the domain is reached. Rapid rotation, not considered in this work, might alter these conclusions. Radii for the end of collapse are given. These are not subject to the same uncertainties as the precollapse models, but they could be increased somewhat if the assumption of complete convective transport is not correct. Some other properties of the models are discussed. It is found that the maximum central temperatures of bodies around $0.1\ M_\odot$ are not affected by departures of the adiabat from constant polytropic index. (auth)

5104 ON THE OSCILLATIONS AND STABILITY OF ROTATING STELLAR MODELS. I. MATHEMATICAL TECHNIQUES. **Tassoul, Jean Louis; Ostriker, Jeremiah P. (Princeton Univ., N. J.). Astrophys. J., 154: 613-26 (Nov. 1968).**

The second-order virial equations are employed to analyze, in a first approximation, the stability of nonuniformly rotating, centrally condensed stellar models. The characteristic frequencies for the lowest seven modes (having a plane of symmetry) are calculated under the assumptions that the angular velocity at equilibrium depends only on the distance from the axis of rotation, that the displacement is a linear function of the positional coordinate r, and that the perturbations are adiabatic. It is not assumed that the rotational effects are small in any part of the star. In the limit of zero rotation, six frequencies correspond to the lowest radial acoustic mode and the Kelvin modes belonging to the second-order spherical harmonics. The seventh mode vanishes when rotation is absent. The acoustic mode, which is now coupled with the axisymmetric Kelvin mode, may become dynamically unstable when the adiabatic exponent falls below a certain critical value. Also, there is one nonaxisymmetric Kelvin mode which becomes overstable, for sufficiently large values of the total angular momentum, at a point corresponding to the instability and possible fission of the classic Maclaurin spheroid. A procedure is outlined by which the various integral quantities, which are required by the stability analysis, can be conveniently calculated. (auth)

5105 RAPIDLY ROTATING STARS. III. MASSIVE MAIN-SEQUENCE STARS. **Mark, James W-K. (Princeton Univ. Observatory, N. J.). Astrophys. J., 154: 627-43 (Nov. 1968).**

The effects of rapid differential rotation on the structure and observable properties of main-sequence stars of 20 to 100 $M_\odot$ were studied using the self-consistent-field method of Ostriker and Mark for the potential theory, while the thermal conditions were treated in such a way that the energy carried by meridional currents is averaged out. The rotation field is assumed constant on cylinders coaxial with the rotation axis, as is suggested by the stability analysis of Goldreich and Schubert. In order to simplify the analysis, a polytropic $P(\rho)$-relation is assumed. This latter assumption restricts the applicability of the investigation to the mass range of the O stars, although the qualitative physical results should apply also to rapidly rotating B stars. It was found that differential rotation (with angular velocity decreasing outward and with equatorial velocities of the observed order) can cause deficiencies of 1 or 2 mag in M_{bol}. In general, the effects of differential rotation are up to an order of magnitude larger than those of uniform rotation for the same equatorial velocity. Furthermore, differential rotation shifts the position of the star in the H-R diagram almost downward along the main sequence, so that a star with rapid differential rotation may be as much as twice as massive as a nonrotating star of the same effective temperature and absolute magnitude. (auth)

5106 FORMAL THIRD INTEGRAL OF MOTION IN A NEARLY SPHERICAL STELLAR SYSTEM. **Saaf, Allan F. (Univ. of Chicago). Astrophys. J., 154: 483-98 (Nov. 1968).**

Some aspects are considered of the problem of constructing a formal third integral, independent of the energy and a conserved component of the angular momentum, for the motion of a star in a time-independent, axisymmetric gravitational field. Potentials which depart slightly from spherical symmetry are assumed, and a third integral is developed as a formal series in powers of a small parameter which characterizes the departure of the system from spherical symmetry. It is shown that the third integral is a generalization of the total angular momentum, in the sense that the third integral reduces to that quantity in the limit that the potential is spherically symmetric. An explicit example of the third integral for stars of low energy confined to a region near the center of a nearly spherical system is considered and a formal integral is developed as a series in powers of a small parameter. Numerical evidence indicates that the new integral is reasonably well conserved and that it is isolating. In addition to this specific example, the problem of the third integral in an arbitrary spherically symmetric potential which is perturbed by an arbitrary but small axisymmetric potential is considered. An approximate solution of the Liouville equation is given and it is shown that with this solution one may write a formal third integral of motion. The technique presented in that derivation is sufficiently general to provide a systematic method for dealing with secular terms that may appear in the solution. Finally, an example of the third integral for nearly circular orbits is presented. This example illustrates the formal techniques developed in the discussion of the solution of the Liouville equation. (auth)

5107 SIMPLIFIED PICTURE OF THE CEPHEID PHASE LAG. **Castor, John I. (Univ. of Colorado, Boulder). Astrophys. J., 154: 793-8 (Nov. 1968).**

By considering the hydrogen ionization zone as a discontinuity which moves in accordance with an energy-jump condition, it is

shown that for a range of conditions coinciding with the Cepheid instability strip the emergent luminosity will vary nearly in phase with the outward velocity. A nonlinear mechanism is suggested to make the luminosity vary just in phase with the velocity. (auth)

5108 NUCLEAR QUASI-EQUILIBRIUM DURING SILICON BURNING. Bodansky, David (Univ. of Washington, Seattle. California Inst. of Tech., Pasadena); Clayton, Donald D.; Fowler, William A. Contract AT(45-1)-1388. Astrophys. J., 16: Suppl. Ser., 148: 299-371(Nov. 1968).

It appeared to Burbidge, Burbidge, Fowler, and Hoyle (1957) that the dominance of the intermediate α-particle nuclei (^{24}Mg, ^{28}Si, ^{32}S, ^{36}Ar, ^{40}Ca) was to be interpreted as being due to a chain of α-particle captures (called the α process) involving these intermediate-mass nuclei and that the composition of the iron group was established by a complete nuclear equilibrium (called the e process) at a subsequent time. In this paper the possibility that the situation is actually more unified than the one presumed for an α, e sequence is investigated—that, in fact, the abundances of the most abundant nuclei between ^{28}Si and the iron group, up to and including ^{57}Fe, have been established by a partial equilibrium in which the nuclei heavier than ^{28}Si are in equilibrium with ^{28}Si under the exchange of photons, nucleons, and α particles. The ^{28}Si itself is not in equilibrium with those light particles, and the heavy nuclei are not in equilibrium among themselves, because the only effective reaction links are those involving light particles and photons. (W.D.M.)

5109 SOLUTION OF THE EQUATIONS OF RADIATIVE TRANSFER IN A FREE-ELECTRON ATMOSPHERE. Bowden, Robert L.; Richardson, Norman R. (Virginia Polytechnic Inst., Blacksburg). J. Math. Phys. (N. Y.), 9: 1753-61(Nov. 1968).

The radiative-transfer equations are solved for an electron-scattering stellar atmosphere as formulated by Chandrasekhar. The solution employs a transformation of the integro-differential form of the transfer equations into singular integral equations for the angular intensities of the radiation field. The Milne problem is solved to illustrate the method. In addition, the relationship is found between the above method of solution and Case's normal-mode expansion method. This leads to an alternate procedure for finding the normal-mode expansion coefficients. As an example of the method, the constant distributed source problem is solved for a half-space medium. (auth)

5110 A NON-LTE THEORY OF OVERLAPPING LINES NEAR THE SERIES LIMIT. Van Blerkom, D.; Hummer, D. G. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Astrophys. J., 154: 741-50(Nov. 1968).

The effects of overlapping on the formation of spectral lines near the series limit were investigated through the introduction of a band model. Numerical solutions were obtained which show that the source function can be increased by a factor of 2 for ϵ = 0.1 and by much larger amounts for smaller ϵ. A criterion is presented to check when overlapping is likely to be important. (auth)

5111 ON THE EXTENDED INFRARED SOURCE IN ARA. Westerlund, B. E. (Univ. of Arizona, Tucson). Astrophys. J., 154: L67-8(Nov. 1968).

An extended source detected recently at 2.2 μ is in excellent positional agreement with a heavily reddened cluster found previously. The observed brightness of 2.2 μ may be fully explained by the radiation from the cluster members. (auth)

5112 THE USE OF [S II] LINES TO DETERMINE INTERSTELLAR REDDENING. Miller, Joseph S. (Univ. of California, Santa Cruz). Astrophys. J., 154: L57-9(Nov. 1968).

Infrared and violet lines of S (II) that originate from the same upper levels are shown to be useful for measuring interstellar reddening of nebulae. (auth)

5113 AN INTERPRETATION OF THE PECULIAR HELIUM STAR HZ 29. Stothers, Richard (Goddard Inst. for Space Studies, New York). Astrophys. J., 154: L91-4(Nov. 1968).

It is suggested that the variability of the peculiar helium star HZ 29 is due to nuclear-energized pulsations in a helium star of high mass. (auth)

5114 STUDY OF STELLAR ROTATION. IV. Van Den Heuvel, E. P. J. (Rijksuniversiteit, Utrecht). Bull. Astron. Inst. Neth., 19: 449-59(June 1968).

Computation of the change in rotational velocity for the secondary in a binary system in which the primary transfers a large fraction of its mass toward the secondary is considered. It is assumed that rotation and revolution are completely synchronized by tidal forces, if the binary period is sufficiently short. The change in angular velocity of rotation of the secondary is computed for the two extreme cases: (1) of uniform rotation, and (2) of conservation of angular momentum in spherical shells in the interior. A third intermediate case is also considered. From these computations it is expected that the average equatorial velocity of rotation $\langle v_e \rangle$ for $A0_p$ stars ranges between 10 and 56 km/sec and for $B5_p$ between 18 and 91 km/sec. For Am stars, $\langle v_e \rangle$ is expected to be less than 64 km/sec. The slow rotation of blue stragglers without abnormal spectra, e.g., 40 Cancri in Praesepe, and of the other slowly rotating B2 to F2 stars, can be explained in the same way. (IAA)

5115 INVESTIGATION OF THE MEANING OF TYPE-O SPECTRA. Underhill, Anne B. (Rijksuniversiteit, Utrecht). Bull. Astron. Inst. Neth., 19: 500-25(June 1968).

Five model atmospheres representing late O-type main-sequence stars, and their spectra are discussed. Four of the models are unblanketed, the opacity being due to H, He(I), He(II), and isotropic coherent electron scattering. In two of the models, log g = 4.0, while in the other two it is 3.7. A fifth model which has log g = 4.0 and in which the blanketing by the strong uv lines has been accounted for in an approximate manner is presented. It is shown that the relative intensity distribution in the continuous spectrum at $\lambda > 2000$ Å is not particularly sensitive to the details of the model construction process, but the spectrum at shorter wavelengths is quite sensitive to the value of log g and sources of opacity. The profiles are predicted for lines of H, He(I), He(II), C(III), O(II), O(III), Ne(II), Mg(II), Si(II), Si(III), Si(IV), Ar(III), Ti(III), Cr(III), and Fe(III), and the equivalent widths are derived using an LTE theory of line formation. (IAA)

5116 STUDY OF STELLAR ROTATION. III. Van Den Heuvel, E. P. J. (Rijksuniversiteit, Utrecht). Bull. Astron. Inst. Neth., 19: 432-48(June 1968).

The changes in orbit are computed for binary systems in which one of the components is rapidly decreasing in mass. Original orbits are assumed to be circular. The mass of the first component is supposed to decrease according to the law $M_1(\tau) = M_1^0 [1 - f(\tau)]$; for $f(\tau)$ the functions $c\tau$, $c\sqrt{\tau}$, and $c\tau^2$ are tried, for five values of the original mass ratio (ranging from 1.00 to 10.0), and the results are listed. Since if Ap stars are runaway stars, the rapid mass ejection is expected to have taken place after a stage of mass exchange, original mass ratios between 4 and 9 are tried; it is found that the period cannot have increased by more than a factor 1.52. For a mass ratio of 5 it is shown that for Ap stars with masses ranging between 3 and 6 $M_\odot$ the expected range in maximum runaway velocities for a characteristic time of mass ejection of 80^d is between 6.25 and 8.5 km/sec and between 0 and 6.5 km/sec for final primary masses of 0.3 $M_\odot$ and 0.7 $M_\odot$, respectively. The expected range in runaway velocities is in reasonable agreement with the possible range in runaway velocities of Ap stars, estimated from their observed space velocity distribution. (IAA)

5117 NUMERICAL EXPERIMENTS CONCERNING THE ROTATIONAL BROADENING OF SPECTRAL LINES. Underhill, Anne B. (Rijksuniversiteit, Utrecht). Bull. Astron. Inst. Neth., 19: 526-36(June 1968).

The theoretical problem of line broadening due to the rotation of a star is reviewed, and a method is given of computing rotationally broadened profiles from knowledge of the monochromatic source function in a model atmosphere. Examples are given of the rotational broadening of Si II λ6347 and of Hγ in a model atmosphere representing a B6V star. The model atmosphere constructed by using only continuous sources of opacity is presented. The numerical techniques must be adapted to the relative value of the natural half-width of the line to the maximum radial velocity displacement $v_R \lambda/c$ due to a velocity of rotation v_R km/sec. The effects of rotational broadening and of microturbulence can be distinguished in the case of lines on the flat part of the curve of growth. Even a small rotation will make such a line shallow whereas microturbulence will reduce the central intensity very little from the value in a stationary nonturbulent atmosphere. The normal central intensities of moderately strong lines in stationary B-type atmospheres are between 0.4 and 0.6. A rotational velocity of 30 km/sec will increase the central intensities to between 0.8 and 0.9. The difference between these two ranges should be easy to detect. (IAA)

5118 ARE WHITE DWARFS SUPERCONDUCTORS? Trubnikov, B. A. Zh. Eksp. Teor. Fiz., 55: 1893-1902(Nov. 1968). (In Russian).

In accord with the Bardeen–Cooper–Schriffer (BCS) theory the transition temperature to the superconducting state depends on density as $T_c \sim n^{\frac{1}{3}}$. On basis of this dependence it is investigated whether stars of the white-dwarf type, for which $T \sim 10^{6}$K and $n \sim 10^{30}$ cm^{-3} are characteristic values, can go over to the superconducting state. Since due to the Meissner effect, such a transition is accompanied by the magnetic field being forced out and by

stripping of the outer sheath, it may be of the nature of an explosion. Ion–acoustic oscillations of a strongly degenerate plasma, in this case, play the same role as phonons do in the ordinary BCS theory. (auth)

5119 ELECTRON TEMPERATURES IN THE OUTER REGIONS OF PLANETARY NEBULAE. Thompson, A. R. (Stanford Univ., Calif.). Astrophys. Lett., 2: 201-4(Dec. 2, 1968).

Electron temperatures and optical depths were derived for a total of eight planetary nebulae using radio spectra and Balmer line isophotes as previously described (Thompson 1967). The resulting values of the temperature are strongly weighted towards the outer parts of the nebulae and fall within a range of 3000 to 10,000°K. A trend towards lower temperatures in the outer regions with increasing nebular radius is found. (auth)

5120 COMPUTER MODELS OF THE PLANETARY NEBULAE NGC 7662 AND IC 418. Flower, D. R. (University Coll., London). Astrophys. Lett., 2: 205-8(Dec. 2, 1968).

Discrepancies between the observed and calculated spectra of the nebulae are discussed. There is evidence for the importance of dynamical effects and filamentary structure and possibly for deviations of the flux of the central star of NGC 7662 from blackbody values in the far ultraviolet. (auth)

5121 EMISSION LINES IN MOVING ATMOSPHERES. Magnan, C. (Institut d'Astrophysique, Paris). Astrophys. Lett., 2: 213-16(Dec. 2, 1968).

Monte Carlo methods were used to compute line profiles in a spherical atmosphere moving with constant radial velocity. Frequency redistribution, frequency–angular correlation, and true absorption are taken into account. (auth)

5122 GENERATION OF MAGNETIC FIELDS BY VISCOUS FORCES IN A NON-UNIFORMLY ROTATING PLASMA. Browne, P. F. (Univ. of Manchester, Eng.). Astrophys. Lett., 2: 217-20 (Dec. 2, 1968).

The different viscous forces exerted by the electron and positive ion gases in a nonuniformly rotating plasma cause electrons to drift relative to ions. The associated current density generates a large scale poloidal magnetic field whose strength is computed. In order to account for the field strengths observed in stars and galaxies, subsequent amplification of such a field by a dynamo or magnetohydrodynamical process is required. (auth)

5123 ANISOTROPIC SCATTERING OF LIGHT IN A SEMI-INFINITE ATMOSPHERE. II. Sobolev, V. V. (Leningrad State Univ.). Sov. Astron. AJ (Engl. Transl.), 12: 420-6(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 528-37(May-June 1968).

The linear integral equations for the brightness functions $\rho(\eta,\xi)$ and $\delta(\eta)$ and the auxiliary functions $\varphi_i(\eta)$ are considered. A connection is established between the functions $\varphi_i(\eta)$ and the function $H(\eta)$ of Chandrasekhar. The albedo of the atmosphere is expressed in terms of the function $H(\eta)$ and its moments. As examples cases of the simplest nonspherical phase functions are considered. (auth)

5124 STRUCTURE OF THE STAR CLUSTER M39. Artyukhina, N. M.; Kholopov, P. N. (State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 440-4(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 556-61(May-June 1968).

A nucleus of radius at least 22.5′ for the cluster M39 is revealed by star counts to 10.1^m B on a plate taken with the wide-angle astrograph of the Shternberg Astronomical Institute. Any corona of bright stars is masked by large background density fluctuations. For stars fainter than 10^m not even the cluster nucleus can be identified by simple counts. To analyze the structure of M39 appropriately one should identify from proper motions all possible cluster members to at least $10-11^m$ within a circle of 2.5° radius about the center. (auth)

5125 STRUCTURE OF THE COLOR-MAGNITUDE DIAGRAM OF THE DOUBLE CLUSTER h AND χ PERSEI. Bronnikova, N. M. (Central Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.), 12: 445-7(Nov.–Dec. 1968). Translated from Astron. Zh., 45: 562-5(May–June 1968).

The several sequences identified by Wildey in the $[M_V, (B-V)_0]$ absolute-magnitude–color diagram for h and χ Persei were tested for reality by means of Lavdovskii's proper motions. The "blue elbow" branch apparently is not real. No definitive statement can be made regarding the branch with the "hollow". The other branches — the contraction branch, the red-supergiant branch, and the evolved main sequence — are real. (auth)

5126 SPECTRA OF Hα EMISSION OBJECTS IN THE DIFFUSE NEBULAE IC 1396 AND SIMEIZ 130. Dibai, E. A.; Esipov, V. F. (State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 448-9(Nov.–Dec. 1968).

Translated from Astron. Zh., 45: 566-7(May–June 1968).

Emission lines were detected in the spectra of objects associated with globules in the nebulae IC 1396 and Simeiz 130. (auth)

5127 ATMOSPHERES OF BETA CANIS MAJORIS STARS. II. DELTA CETI. Orlov, M. Ya. (Central Astronomical Observatory, Kiev). Sov. Astron. AJ (Engl. Transl.), 12: 450-3 (Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 568-71(May-June 1968).

Equivalent widths and central depths were measured for the hydrogen and helium lines on spectrograms of δ Cet (dispersion 14 A/mm). As for γ Peg, these parameters exhibit no perceptible variations over the period of radial-velocity variation. The electron density in the atmosphere of δ Cet is determined. (auth)

5128 EFFECT OF INITIAL CHEMICAL COMPOSITION ON THE EVOLUTION OF STARS OF LARGE MASSES. Frantsman, Yu. L. (Astronomical Council, Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 454-8(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 572-7(May-June 1968).

The effect of initial chemical composition on the evolution of stars of large mass within the limits of the main sequence is discussed. The evolutionary time of 4 $M_\odot$ stars at various stages of evolution is given. The initial chemical composition has a very strong effect on the star's evolutionary time, which varies by more than a factor of 10 for the compositions considered for the 4 $M_\odot$ stars. The initial chemical composition does not affect in the same way the duration of the different stages of the evolution. The basic data which depict the evolution of 4.8 and 16 $M_\odot$ stars is given. The effect of the initial chemical composition on the speed of evolution decreases as one goes to the more massive stars. On the basis of the calculations, mass–luminosity and mass–radius diagrams for stellar models situated at various evolutionary stages are given. The observational data from double stars are plotted for comparison. The theoretical relations agree satisfactorily with the observations. (auth)

5129 NGC 7293 FILAMENTS AND THEIR SIGNIFICANCE. Vorontsov-Vel'yaminov, B. A. (State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 389-91(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 489-91(May-June 1968).

The shape, size, and mass of the most tenuous radial filaments in the Helix planetary nebula NGC 7293 are described. The filament dimensions are about 150 × 3000 astronomical units, and the mass is 5×10^{25} g. The conclusion is that these filaments are corpuscular streams ejected by the nucleus over a certain time, and that they build up in successive ejections in what may well be the process responsible for the envelopes of planetary nebulae. The emission of the corpuscular streams seems to be concentrated in the equatorial plane of the nucleus, forming envelopes in the shape of a torus. (auth)

5130 BRIGHT MAIN-SEQUENCE STARS IN THE CLUSTER NGC 7142. Sharov, A. S. (State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 550-1(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 693-5(May-June 1968).

The stars located to the left of the giant branch on the upward extension of the main sequence in the color–magnitude diagram are shown to be cluster members. (auth)

5131 BROADENING OF HYDROGEN SPECTRAL LINES BY PLASMA ELECTRONS. Minaeva, A. A. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 459-63(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 578-84(May-June 1968).

The broadening of hydrogen spectral lines by plasma electrons is considered. The main attention is devoted to the lines of the Lyman, Balmer, and Paschen series. Broadening by electrons is considered within the framework of the impact approximation. An estimate is given of the width γ_e due to the linear and quadratic Stark effect. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 5189.

5132 OCCULTATION STUDIES OF WEAK RADIO SOURCES. LIST 2. Hazard, C.; Gulkis, S.; Sutton, J. (Cornell-Sydney Univ., Ithaca, N. Y.). Astrophys. J., 154: 413-22(Nov. 1968).

The positions and structures of ten radio sources are derived from occultation observations. Optical identifications are suggested for all ten sources. (auth)

5133 LINEAR POLARIZATION OF RADIO SOURCES AT 2,07-CENTIMETER WAVELENGTH. Hobbs, R. W.; Hollinger, J. P. (Hulburt Center for Space Research, Washington, D. C.). Astrophys. J., 154: 423-9(Nov. 1968).

Measurements of the linearly polarized 2.07-cm-wavelength radiation from 29 radio sources were made, using the 140-foot paraboloidal reflector at the National Radio Astronomy Observatory. In addition, the linear polarization was measured for several regions of five of these sources: Taurus A, Centaurus A, 3C 398, Cygnus A, and Cassiopeia A. Sixteen of the sources are extragalactic, including six quasi-stellar radio sources and five variable radio sources. (auth)

5134 THE EFFECTS OF STELLAR EVOLUTION ON THE PROPERTIES OF H II REGIONS. **Hjellming, Robert M. (Case Western Reserve Univ., Cleveland). Astrophys. J., 154: 533-41 (Nov. 1968).**

The evolution of the radio flux density and the excitation parameter for H(II) regions was studied in terms of the effects of evolution of the exciting stars. These quantities were found to be strongly dependent on age but independent of the size and density structure of H(II) regions. A diagram showing the dependence of the radio flux density on distance, age, and the spectral types of exciting stars is presented and is utilized in connection with data for twenty-five H(II) regions in order to discuss the determination of ages, the need for additional sources of excitation, and the question of whether the H(II) regions are ionization or density bounded. The data are used primarily to obtain a calibration of the spectral types of O stars as a function of effective temperature. (auth)

5135 SIMULTANEOUS OBSERVATIONS OF THE OPTICAL AND X-RAY SPECTRA OF SCO XR-1. **Chodil, G. (Univ. of California, Livermore); Mark, Hans; Rodrigues, R.; Seward, F. D.; Swift, C. D.; Turiel, Isaac; Hiltner, W. A.; Wallerstein, George; Mannery, E. J. Astrophys. J., 154: 645-54 (Nov. 1968).**

The results of two simultaneous optical and x-ray intensity measurements of the cosmic x-ray source Sco XR-1 are reported. Rocket-borne proportional counters were used to measure the x-ray spectra from 2 to 20 keV on May 18, 1967, and September 29, 1967. Optical intensities were measured during the rocket flights at the Cerro Tololo Inter-American Observatory in Chile. The x-ray data could be approximated by thermal bremsstrahlung from a hot plasma for both experiments, with a temperature of 8.1×10^{7}° and 4.6×10^{7}°K, respectively, and optical intensities of B = 12.83 and 12.49, respectively. The x-ray spectrum is extrapolated into the optical region and compared with the optical measurements. Agreement can be obtained when self-absorption in the hot plasma and interstellar extinction are considered in extrapolating the x-ray spectrum. (auth)

5136 THE SOFT X-RAY SPECTRUM OF SCO XR-1. **Hill, R. W.; Grader, R. J.; Seward, F. D. (Univ. of California, Livermore). Astrophys. J., 154: 655-60 (Nov. 1968).**

The x-ray spectrum of Sco XR-1 was measured in the energy range from 0.6 to 9 keV. A change of approximately a factor of 2 in intensity was noted since the previous measurement in October 1965. The spectra of the diffuse background and of a group of sources near the galactic center were also measured. (auth)

5137 SEARCH FOR HIGH-ENERGY GAMMA RAYS FROM CP 1133. **Charman, W. N. (Atomic Energy Research Establishment, Harwell, Eng.); Jelley, J. V.; Orman, P. R.; Drever, R. W. P.; McBreen, B. Nature (London), 220: 565-6 (Nov. 9, 1968).**

Several proposed models for pulsars suggest the possibility that the high-energy γ rays may be emitted by such objects, and an attempt is described to detect high-energy ($\sim 10^{14}$-eV) neutral cosmic rays from CP 1133, using the atmospheric Cherenkov technique. A modified version of the searchlight installation at Harwell was used (Quart. J. Roy. Astron. Soc., 4: 275(1963)), with two 90-cm-dia light receivers operating in coincidence, the coincidences being sorted in a 512-channel multiscaler analyzer. Cycling of the analyzer was based on the heliocentric period of the source, with Doppler corrections for the Earth's orbital motion and axial rotation. Count totals as a function of pulsar phase are shown graphically, with indications of statistically significant peaks, and details of the observations are tabulated, including mean count rates for all air showers and estimated energy thresholds. If the observations are accepted as suggesting emission of cosmic rays from CP 1133, the question of their nature arises; γ rays are obvious candidates, since they should suffer no significant losses by photon–photon collision over the suggested distance (~50 pc) of this source. The possibility that they are neutral primaries cannot, however, be ruled out. Proton primaries would be ruled out on the grounds of deflexion in interstellar magnetic fields, but neutron primaries cannot be entirely eliminated. (UK)

5138 PHYSICAL CHARACTERISTICS OF SCO X-1. **Gatewood, George; Sofia, Sabatino (Univ. of South Florida, Tampa). Astrophys. J., 154: L69-70 (Nov. 1968).**

New arguments are presented which confirm the membership of Sco X-1 in the Scorpio–Centaurus association. The position of the source below the subdwarf region in the H–R diagram indicates that the x-ray star is an evolved compact object of the nature of a white dwarf. The low age of the association suggests that this object might have been massive once and that what we see now is a remnant of a supernova and therefore possibly a neutron star. (auth)

5139 POLARIZATION AND TIME VARIATION OF OH SOURCES. **Coles, William A. (Univ. of California, San Diego); Rumsey, V. H.; Welch, W. J. Astrophys. J., 154: L61-5 (Nov. 1968).**

A program of polarization observations on galactic OH sources has revealed rapid time variations in the source W33 at 1665 MHz. It also seems likely that a slow variation has occurred in the source W3. (auth)

5140 NUMEROLOGICAL CONSIDERATIONS RELEVANT TO QUASI-STELLAR OBJECTS. **Dyson, Freeman J. (Inst. for Advanced Study, Princeton, N. J.). Astrophys. J., 154: L37-9 (Nov. 1968).**

On the assumption that quasars are powered by a random succession of local gravitational-collapse events, order-of-magnitude estimates are derived for the rise time of light fluctuations, the electron density, the emission temperature, and the peak luminosity. All four quantities are found to be within the range of the observed values, provided that the luminosities are deduced from the cosmological-distance hypothesis. The agreement with observation is spoiled if quasars are assumed to be local objects. (auth)

5141 THE DISTRIBUTION OF REDSHIFTS IN QUASI-STELLAR OBJECTS, N-SYSTEMS, AND SOME RADIO AND COMPACT GALAXIES. **Burbidge, Geoffrey (Univ. of California, San Diego. Cambridge Univ., Mass.). Astrophys. J., 154: L41-8 (Nov. 1968).**

The frequency of occurrence of absorption and emission red shifts at z = 1.95 in quasi-stellar objects is re-evaluated. It is concluded that recent data strengthen the earlier conclusion that this number has great significance. The distribution of red shifts among QSOs, N systems, and some compact systems and radio galaxies which are closely related in their physical characteristics and in which only emission lines are seen is then investigated. It is shown that there appears to be a significant red shift peak at z = 0.061 and possibly at some multiples of this value. There appears to be no effect of this kind in the red shifts of normal galaxies. The implication of these results is briefly described, and it is concluded that large intrinsic red shift components may often be present. (auth)

5142 VARIABILITY OF THE LINEAR POLARIZATION OF 3C 120 AND 3C 279. **Hobbs, R. W.; Hollinger, J. P.; Marandino, G. E. (Naval Research Lab., Washington, D. C.). Astrophys. J., 154: L49-51 (Nov. 1968).**

The linear polarization at 2.07-cm wavelength of seven variable radio sources was measured during three observing periods between Dec. 1965 and Aug. 1967. The linear polarization of 3C 120 and 3C 279 changed significantly over this time interval. (W.D.M.)

5143 A SEARCH FOR DISCRETE SOURCES OF COSMIC GAMMA RAYS OF ENERGIES NEAR 2×10^{12}eV. **Fazzio, G. G. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.); Helmken, H. F.; Rieke, G. H.; Weekes, T. C. Astrophys. J., 154: L83-9 (Nov. 1968).**

By use of the atmospheric Cherenkov nightsky technique, a study was made of the cosmic-ray air-shower distribution from the direction of thirteen astronomical objects. These include the Crab Nebula, M87, M82, quasi-stellar objects, x-ray sources, and recently exploded supernovae. An anisotropy in the direction of a source would indicate the emission of gamma rays of energy 2×10^{12} eV. No statistically significant effects were recorded. Upper limits of 3 to 30×10^{-11} gamma ray cm^{-2} sec^{-1} were deduced for the individual sources. (auth)

5144 AN UPPER LIMIT FOR THE OPTICAL LUMINOSITY OF THE PULSATING RADIO SOURCES CP 0950 AND CP 1133. **Kristian, Jerome (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 154: L99-100 (Nov. 1968).**

Three recent independent sets of measurements for the radio positions of the pulsating radio sources CP 0950 and CP 1133 enable a very faint upper limit to be set on the optical luminosity of these sources. The measurements were made at Cambridge and Cal Tech. The limiting visual magnitude is estimated to be about 21.5. (W.D.M.)

5145 THE LOCATION OF THE X-RAY SOURCE IN VELA. Gursky, H.; Kellogg, E. M.; Gorenstein, P. (American Science and Engineering, Cambridge, Mass.). Astrophys. J., 154: L71-4(Nov. 1968).

The location of an x-ray source in Vela as obtained from sounding-rocket data is presented. The object may be the previously reported Vel XR-1, but its position does not coincide with any of the outstanding objects in the vicinity which have recently been suggested as candidates for this source. (auth)

5146 A RADIO SOURCE NEAR THE X-RAY SOURCE GX3+1. Goss, W. M. (CSIRO, Sydney); Shaver, P. A. Astrophys. J., 154: L75-6(Nov. 1968).

The properties of a radio source found within 2′ of the ultraviolet object identified with GX3 + 1 are discussed. The continuum spectrum of the radio source appears to be thermal. (auth)

5147 NARROW-BAND AND UBV PHOTOMETRY OF GX3+1 AND TWO WOLF-RAYET STARS. Johnson, H. M. (Lockheed Missiles and Space Co., Palo Alto, Calif.); Golson, J. C. Astrophys. J., 154: L77-82(Nov. 1968).

GX3 + 1 varies in several parts of the spectrum defined by narrow and UBV pass bands. The central part of broad He (II) λ4686 is a steady feature, while weaker features in the pass bands used for the β' index around λ4861 are variable. Helium excitation is discussed. The Wolf–Rayet stars HD 50896 and HD 45166 did not vary significantly during periods of about an hour, although they have been reported previously as variable in longer times. (auth)

5148 BRIGHTNESS DISTRIBUTIONS OF RADIO SOURCES AT 2695 MHz. Bash, F. N. (National Radio Astronomy Observatory, Green Bank, West Virginia). Astrophys. J., 16: Suppl. Ser., No. 149, 373-404(Nov. 1968).

Results of two-element interferometer observations of 234 radio sources are given. The data were taken with the National Radio Astronomy Observatory's interferometer, operating at 2695 MHz, with five antenna separations from 10,000 to 24,000 λ. One-dimensional brightness-distribution models are presented for 184 of the sources observed. These models give the brightness distribution of the source projected on the interferometer's direction of resolution. Relations are sought between angular dimensions of the radio sources and other observable parameters, and observational selection effects which could give rise to such relations are discussed. On the scale of the available resolution, ~2″, only thirteen of the 234 sources observed had all fringe visibilities less than 0.05. It is found that the quasi-stellar sources with flat radio spectra are small in angular size compared with those with steep spectra, that the apparently bright ones are small compared with the fainter ones, and that the highly polarized ones are all unresolved. For radio galaxies the largest angular dimension apparently increases with increasing flux density and increasing polarization. The spectral indices and angular dimensions of radio galaxies show no relation. No relations were found between parameters of the brightness-distribution models and another observable parameter for the unidentified sources. (auth)

5149 SOME PROBLEMS IN HIGH-ENERGY ASTROPHYSICS. Matsuoka, Masaru; Sato, Fumitaka; Tabara, Hiroto. Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 4: 253-70(Apr. 1968). (In Japanese).

A discussion is given on high-energy astrophysics with emphasis on x-ray emission mechanisms. It is suggested that the main process with respect to x-ray emission may be interpreted as thermal radiation from hot tenuous plasma, for both cosmic x-ray sources and isotropic components. (IAA)

5150 PULSATING RADIO SOURCES: A NEW CLASS OF ASTRONOMICAL OBJECTS. Birkle, Kurt (Landessternwarte, Heidelberg). Sterne Weltraum, 7: 179-83(July 1968). (In German).

A recently discovered class of pulsating radio sources, denoted as CP 0834, CP 0950, CP 1133, and CP 1919 is discussed. Position (in terms of equatorial and galactic coordinates), periods, mean energy flow density, integrated electron density, and mean pulse profiles are given for the four radio sources. The relationship between the amplitude and frequency of the observed pulses is investigated, with emphasis on the long-term pulse variations. Theories which attempt to prove that white dwarfs and neutron stars are the sources from which newly discovered pulses emanate are also discussed. (IAA)

5151 INTENSITY VARIATIONS IN PULSARS. Galt, J. A. (Dominion Radio Astrophysical Observatory, Penticton, British Columbia); Gower, A. C. Astrophys. Lett., 2: 209-11(Dec. 2, 1968).

Observations of pulsing radio sources were made at 113 MHz with a 25.6-m paraboloid using photographic-recording techniques. Each of the three sources investigated showed a different pattern of variability. Autocorrelation analysis of the pulse intensities failed to reveal any periodicities between several minutes and several hours. (auth)

5152 LUNAR OCCULTATIONS OF THE RADIO SOURCE SAGITTARIUS A. Maxwell, A.; Taylor, J. H. (Harvard Radio Astronomy Station, Fort Davis, Tex.). Astrophys. Lett., 2: 191-4(Dec. 2, 1968).

Lunar occultations of the radio source Sgr A, presently identified as the galactic nucleus, were observed at nine frequencies in the continuum between 230 and 2400 MHz. The results show that the half-power diameter of the source is about 2 × 3 arc min and that the radio contours are remarkably smooth, there being little significant structure down to a resolution of 20 arc sec. The position of the source was measured to an accuracy of ±15 arc sec and new values for flux densities in the decimeter band were determined. The new data suggest that the spectral index of Sgr A is about −0.25, while that of the surrounding region is about −0.7. (auth)

5153 POSSIBLE STRUCTURE OF WIDE EMISSION LINES IN THE SPECTRA OF SOME QUASARS. Komberg, B. V. (Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 401-5(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 504-9(May-June 1968).

Some general features characteristic for lines in the spectra of quasars are pointed out, and the question of the identification of weak absorption lines is considered. In particular, the situation in the identification of absorption lines for which $z_{i\ abs} > \bar{z}_{i\ em}$ was investigated. Making the assumption of splitting of the corresponding emission lines, it is shown that one can thereby reidentify these lines in such a way that for them the ordinary condition for the spectra of the quasars is fulfilled, namely $z_{i\ abs} < \bar{z}_{i\ em}$. (auth)

5154 ANALYSIS OF THE NATURE OF A QUASAR NUCLEUS FROM STATISTICAL PROPERTIES OF ITS OPTICAL VARIABILITY. Gudzenko, L. I.; Ozernoi, L. M.; Chertoprud, V. E. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 392-400(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 492-503(May-June 1968).

Analysis of a prolonged sequence of observations of the optical variability of the quasar 3C 273 reveals a significantly non-Gaussian character of the brightness distribution. From this fact one can reject with considerable confidence the widely held hypothesis that the source of radiation—the nucleus of the quasar—is a complex of a large number of independent objects of the same kind (for example, a compact cluster of stars which from time to time undergo random collisions with subsequent explosions as supernovae). With simple assumptions one can estimate the coherence intervals in the observed brightness curve and show that even the assumption of connectedness of the explosions of the individual supernovae contradicts the observed variability picture. The result of the analysis suggests the alternative concept that the source of radiation is a system of strongly interacting regions, i.e., that it is in essence a single body. The present paper contains comprehensive arguments for the conclusions which were given previously. (auth)

5155 RADIOLUMINOSITY FUNCTION OF GALAXIES AND RELATED PROBLEMS. Sholomitskii, G. B. (Shternberg State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 381-5(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 478-84(May-June 1968).

In an earlier article (1967), the author had shown, by taking into account observational selection effects in the optical range and radio-frequency range, that available data on sources of emission associated with galaxies are satisfied by the radioluminosity function (RLF) which is expressed by a power law. With some slight quantitative departures from the radioluminosity function stated by Longair (1966), presentation of the RLF in the form of the power law, where $\Gamma > 2$, leads to a fundamentally important role of low-radioluminosity galaxies in the case of presently observable parameters of the metagalaxy. Here, reference is made primarily to the basic contribution made by faint galaxies to the radio-emission background of the metagalaxy (26 and 33°K at 178 MHz frequency in the homogeneous isotropic models $\Lambda = 0$, $q_0 = \frac{1}{2}$, and $\Lambda = q_0 = 0$), and possibly also the contribution made to injection of cosmic rays into intergalactic space, as well as the significant effect of screening of distant sources by galaxies inferable from comparisons of the observable brightness of the isotropic radio background and the relatively low mean surface brightness of galaxies. The selection effect in radio observations, an effect related to clustering of galaxies and the limited resolving power of radio telescopes, is indicated as a possible reason for the RLF discontinuity reported by many others in the region $P_{178} \simeq 4 \cdot 10^{25}$ W/Hz · sr. (auth)

5156 REGION OF DIMINISHED 21-cm LINE INTENSITY NEAR THE RADIO SOURCE W49. Gosachinskii, I. V.; Bystrova, N. V. (Central Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.), 12: 548-9(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 691-3(May-June 1968).

The region of reduced brightness of the neutral-hydrogen radio line at +17 km/sec radial velocity near the W49 source results from a drop in the kinetic temperature of the gas. The physical parameters of the cool cloud are determined from observations of the absorption line. (auth)

5157 POSITION OF A SOURCE OF SMALL ANGULAR SIZE IN THE CRAB NEBULA. Matveenko, L. I. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 552-3 (Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 695-7(May-June 1968).

The results are reported of measurements of the right ascension of the Crab Nebula at wavelengths of 3.5 and 7.9 m, and of a small-sized source inside the nebula at 7.9 m. The radio source 3C 123 was adopted as a reference source. At 7.9 m the right ascension of the Crab Nebula is displaced $15'' \pm 12''$ to the east of the position of the binary star; at 3.5 m, $-13'' \pm 6''$ to the west. The small-diameter source is displaced $36'' \pm 27''$ to the east. (auth)

Solar Phenomena

Refer also to abstracts 5290, 5298, and 5300.

5158 STRUCTURE AND MOVEMENT OF SOLAR NOISE STORMS. Daigne, G. (Observatoire de Paris, Meudon, France). Nature (London), 220: 567-8(Nov. 9, 1968).

A study was made of ten noise storms, the relative positions of type-I sources and the associated continuum being measured. The period of observation for each storm varied between 20 and 90 min, and the continuum flux of the storms was between 1 and 5×10^{-22} W/m^2/Hz. The data were obtained with an E–W multilobe interferometer (Vinokur, Ann. Astrophys., 31: 457(1968)). For each storm a curve showing the number of type-I bursts, observed as a function of E–W position, was drawn. Results for the storm of July 30, 1967 indicated the existence of two types of motion, and there were two distinct storm centers. After flare commencement the positions of the two centers oscillated almost in phase with one another, but with different amplitudes (1 arc min for the western source and 4 arc min for the eastern source). The motion of the eastern source was so large that it was certainly real. The results lead to the following generalizations: The emission of type-I bursts is physically localized into zones in the solar corona, which may be termed burst "excitation sources"; their angular diameter is <1.5 arc min, and more than one such source may exist during a storm. The position of a simple one-component center moves during the evolution of a storm; this motion is approximately described as an oscillation with an amplitude of several arc minutes, sometimes superposed on a linear eastward motion of several tens of km/sec. The sources are, in general, very localized, and the existence of such relatively small zones of excitation implies that magnetic configuration may play a part in development of the bursts. If the motions of the excitation sources correlate with changes in magnetic field structure, then type-I bursts may help to trace the evolution of active centers in the corona. (UK)

5159 ULTRAVIOLET SOLAR IMAGES FROM SPACE. Goldberg, Leo; Noyes, Robert W.; Parkinson, William H.; Reeves, Edmond M.; Withbroe, George L. (Harvard Univ., Cambridge, Mass.). Science, 162: 95-9(Oct. 4, 1968).

OSO-IV has obtained valuable new data on the three-dimensional structure of the Sun's atmosphere. Results are discussed at some length and examples of spectroheliograms are given. As examples of some of the areas of study opened up by these data, two broad analysis programs being undertaken are described and several other promising lines of attack are listed. (W.D.M.)

5160 ABUNDANCE ANALYSIS FROM EXTREME-ULTRAVIOLET EMISSION LINES. Zirin, Harold (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Astrophys. J., 154: 799-801(Nov. 1968).

The analyses are criticized on grounds that the chromosphere–corona transition is in dynamic equilibrium and is insufficiently understood for quantitative analysis. A detailed critique of Pottasch's analysis is given. (auth)

5161 COLLISIONLESS HEATING OF THE SOLAR-WIND PLASMA. I. THEORY OF THE HEATING OF COLLISIONLESS PLASMA BY HYDROMAGNETIC WAVES. Barnes, Aaron (Ames Research Center, Moffett Field, Calif.). Astrophys. J., 154: 751-9(Nov. 1968).

The general theory of heating of collisionless plasma by hydromagnetic waves is derived. It is shown that damping of fast-mode hydromagnetic waves can heat both protons and electrons, enhancing the "component" of kinetic (ion or electron) temperature parallel to the mean magnetic field, but not affecting the transverse temperatures. A numerical calculation of the heating associated with fast-mode waves as a function of propagation direction is given, and a qualitative summary of the ways in which the heating depends on plasma conditions is presented. (auth)

5162 SOLAR X RAYS AND RELATED PHENOMENA. Lundbak, Asger (Danish Meteorological Inst., Copenhagen). Ann. Geophys., 24: 799-805(July-Sept. 1968).

An extraordinarily high level of solar x-ray activity with several peaks in the intervals 0 to 3 and 0 to 8 Å is characteristic of the period March 14–April 13, 1966. It is preceded by a rather quiet period March 3–12 and is evidently connected with the two active regions on the Sun numbered 8207 and 8223 in the McMath–Hubert plage system. The magnetic properties of these are classified as gamma type (Mt. Wilson system) during some central days for x-ray activity. Further, both of these regions were active sunspot regions during the preceding solar evolution. For comparison, a period of correspondingly high x-ray activity took place in the beginning of July 1966, and again an active sunspot region with gamma-type magnetism occurred. Reference is also made to the active period at the end of May, 1967. The March x-ray activity followed just after high geomagnetic activity (Kp = 7) early on March 14 with no sudden commencement, whereas similar geomagnetic activity preceded by sudden commencement occurred on March 23, $1\frac{1}{2}$ to 2 days after the central meridian passage of region No. 8207. More moderate geomagnetic activity took place April 1–2 and July 8–9, preceded by sudden commencement in both cases. The x-ray results in question are due to real-time reception from Explorer 30, mainly at Rude Skov near Copenhagen, and it is estimated that 5 to 10% of the x-ray peaks, which occurred in the above periods, are actually recorded here. It is noteworthy in any case, that the highest peak recorded (i.e., 0 to 3 Å surpassing 1.7×10^{-4} erg cm^{-2} sec^{-1}) was contemporary with a very great increase in cosmic-noise absorption, which had its maximum just before 10.00 UT on March 20, 1966. (auth)

5163 ELECTROMAGNETIC SOLAR–TERRESTRIAL EVENTS BETWEEN FEBRUARY 5–9, 1965. Bouska, Jan (Geophysical Inst., Prague). Ann. Geophys., 24: 807-12(July-Sept. 1968).

Some solar, interplanetary, and magnetospheric events occurring before and during the magnetic storm on February 6, 1965 were investigated from the data of several observatories and Earth satellites. Results are discussed. The positive correlation between K_p and PCA is confirmed. The anomalous behavior of solar protons and PCA around ssc shows their mutual dependence. Relations among micropulsations, K_p, and aurora are proved. The characteristic development of the Forbush effect in connection with the magnetic disturbances in successive days is observed. (auth)

5164 SPECTRA OF SELECTED RADIO EVENTS OF MARCH AND JULY 1966. Castelli, John P.; Aarons, Jules (Air Force Cambridge Research Labs., Bedford, Mass.). Ann. Geophys., 24: 813-19(July-Sept. 1968).

Spectra of the peak flux of microwave radio bursts in March and July, 1966 were investigated. A tendency exists for different regions to have different characteristic burst spectra. In the March period, the high level of activity resulted from activity within McMath plage regions 8207 and 8223. The former was associated with bursts whose intensities favored decimeter-wavelength emission, while the latter generally was responsible for bursts having a typical microwave spectrum with flux increasing in the high-frequency direction. It is felt that the latter spectrum is often associated with proton flare regions. In comparison with these regions, 8362, the source of the proton flare of July 7, 1966 had a history of relatively few important events. Their spectra like those from 8223 were typically microwave with a negative spectral index. Incomplete spectra of bursts from this and other regions are seen as related to propagation considerations in the flare-burst altitude area. The general similarity of radio burst spectra identified with particular regions suggests the possibility of classification of solar events and active regions by their microwave burst spectra. (auth)

5165 PENETRATION OF SOLAR PROTONS TO FOUR EARTH RADII IN THE EQUATORIAL PLANE. Fillius, R. Walker (Univ. of California, San Diego, La Jolla). Ann. Geophys., 24: 821-40 (July-Sept. 1968).

On February 5, 1965, March 24, 1966, July 7, 1966, August 28, 1966, and September 2, 1966, solar protons in the 40- to several-hundred-MeV range were monitored by satellite Explorer 26 at low

L values inside the boundary of trapped radiation near the geomagnetic equator. The arrival of particles was prompt whenever the satellite was in a position to see them. The arrival of the February 5 protons occurred 60 ± 12 minutes after the flare was observed; the March 24, 1966 protons arrived 38 ± 3 minutes after the flare; and the August 28, 1966 protons 66 ± 5 minutes after the flare. The March event was seen simultaneously by Vela 2A and 2B, and by OGO-I outside the magnetosphere. The arrival, intensity, and time profiles at the different spacecraft are comparable. Following the event of September 2, 1966, solar protons between 40 and 250 MeV were present for several days. The peak flux of 4500 ± 500 cm^{-2} sec^{-1} at 1540 UT and the decay time constant of about 8½ hours correspond closely with simultaneous measurements made by satellites 1963-38C and 1966-70A above the polar caps. The spatial distribution was characterized by a plateau of constant intensity equal to that seen over the polar caps, bordered by a region of east–west asymmetry below the particle cutoffs for some directions of arrival, terminated by the final cutoffs for east-bound particles. The cutoffs are below their classical Störmer values, but they are empirically described by a modified Störmer theory. The cutoff altitudes are lowered during the magnetic storm, and the limited sample correlates better with K_p than with D_{st}. It can be shown that a symmetrical ring current is expected to raise the equatorial cutoffs, so that some other mechanism is needed to account for the storm effect. The geomagnetic tail may account for this mechanism. The particles seen in these events show no evidence for merging with the trapped radiation and becoming permanently trapped. (auth)

5166 SOLAR PROTONS OBSERVED AT 1100 KM DURING MARCH 1966. Bostroem, C. O. (Johns Hopkins Univ., Baltimore). Ann. Geophys., 24: 841-5(July-Sept. 1968).

Satellite 1963 38C observed solar protons in the polar regions at 1100 km altitude during the period March 22–27, 1966. Two distinct events are observed which are attributed to the importance-2 flares at 2138 UT, March, 21, and at 0225 UT, March 24. The time history and spectra of the two events for protons from 1.2 to >25 MeV are presented and discussed. (auth)

5167 PROBABLE VALUES OF THE TIME OF RISE FOR THE FORTHCOMING SUNSPOT CYCLES. Xanthakis, John. Prakt. Akad, Athenon, 42: 185-94(1967).

It is demonstrated that each of two groups of sunspot cycles of the same polarity, N = 2k + 1 and N = 2K, can be subdivided into two subgroups, each of which presents an individual periodic variation. The periods of these variations are very probably multiples of eight sunspot cycles for cycles with N = 2K + 1 and ten sunspot cycles for cycles with N = 2K. For the current cycle N = 20, the value of the parameter T is equal to 4.1 ± 0.1. In view of the fact that the minimum of cycle N = 20 occurred in 1964.7, it is concluded that the maximum of cycle N = 20 will probably occur in 1968.8 ± 0.1. (IAA)

5168 SOLAR ACTIVITY IN THE YEAR 1966 FROM THE OPTICAL AND RADIO OBSERVATIONS OBTAINED AT THE TRIESTE ASTRONOMICAL OBSERVATORY. Abrami, Alberto (Osservatorio Astronomico, Trieste, Italy). Soc. Astron. Ital., Mem., 39: No. 1, 39-52(1968).

A discussion is given on the results of optical observations of the solar photosphere obtained at Trieste in 1966. Comments are offered on the current solar cycle and its considerable north–south asymmetry. The results of radio observations at 239 MHz make possible a preliminary investigation of the correlations between enhancements of the radio flux and photospheric phenomena and between chromospheric flares and radio bursts at that frequency. (IAA)

5169 SOLAR LYMAN-ALPHA VARIATIONS IN MARCH AND MAY, 1966. Fossi, B. Monsignori; Poletto, G.; Tagliaferri, G. L. (Osservatorio Astrofisico, Arcetri, Italy). Soc. Astron. Ital., Mem., 39: No. 1, 201-6(1968).

A description is given of daily measurements of solar Lyman-α flux during March and May 1966. The data were obtained by telemetry of the SOLRAD 8 satellite. A comparison is made between the Lyman-α fluxes and the estimated values of the Ca II flux. A similar comparison is made with the daily fluxes of several radio frequencies. This makes it possible to draw conclusions about the physical conditions of the emitting region. (IAA)

5170 VARIATION OF THE SIZE OF FLOCCULI FROM THE CENTRE TO THE LIMB OF THE SOLAR DISC. Macris, Constantin J. (Astronomical Inst., Athens). Soc. Astron. Ital., Mem., 39: No. 1, 179-88(1968).

A discussion is given on changes in the size of the flocculi in spectroheliograms of Ca II from the center of the limb of the solar disk. The correction factor for the reduction of the sizes in the center of the solar disk is established. This correction differs widely from the correction factor cos θ. The deviation observed is traced to two causes: (1) the height of the flocculi within the solar atmosphere, and (2) the decrease in their number in the direction from the center to the limb of the Sun. This is caused by the apparent combination of two or more flocculi, due to foreshortening. (IAA)

5171 OBSERVATION OF THE SOLAR TOTAL ECLIPSE OF NOV. 12, 1966: TECHNIQUE FOR DETERMINING THE OCCULTATION OF THE SOLAR LIMB AND INITIAL RESULTS OF PHOTOELECTRIC RECORDING. Cimino, M.; De Biase, G. A.; Bartolini, U. (Osservatorio Astronomico, Rome). Soc. Astron. Ital., Mem., 39: No. 1, 125-35(1968). (In Italian).

A description is given of some preliminary results and brief critical assessment of darkening measurements of the solar limb at λ = 4930 Å made during the total eclipse of Nov. 12, 1966 at Bagé, Rio Grande do Sul, Brazil. A chart shows the luminous intensities of the solar enhancements obtained from a combination of analog and digital recordings read every 10^{-1} sec. An analysis of the measurement dispersion relative to the mean curve ensures that the random errors are much smaller than systematic errors. (IAA)

5172 DETERMINATION OF THE LOCATION OF THE SOLAR MAGNETIC POLES FROM AN EXAMINATION OF THE CORONAL POLAR RAYS. Croce, Vincenzo (Osservatorio Astronomico, Rome). Soc. Astron. Ital., Mem., 39: No. 1, 53-71(1968). (In Italian).

A determination was made of the location, within the solar globe, of the source points of the trajectories of the coronal polar rays, considered as traces of the lines of force of a general magnetic field, with reference to the Feb. 15, 1961, and Nov. 12, 1966, total eclipses. The size, direction, and spot/cycle relation of the magnetic solar dipole were determined on the basis of photographic records at the Rome Observatory. Some statistical geometric considerations on the real distribution of the polar rays were made. (IAA)

5173 MAGNETOSONIC WAVE PROPAGATING ACROSS A MAGNETIC FIELD IN A WARM COLLISIONLESS PLASMA. Fredricks, R. W.; Kennel, C. F. (TRW Systems, Redondo Beach, Calif.). J. Geophys. Res., 73: 7429-35(Dec. 1, 1968).

Propagation of the magnetosonic wave across the magnetic field in a warm, Maxwellian multicomponent plasma is studied for small electron cyclotron radius and for both small and unrestricted ion cyclotron radius. This wave has negative dispersion (phase speed ω/k decreasing with increasing k) everywhere on the $\omega-k$ plane, in agreement with the asymptotic results of Macmahon. The three-wave interaction of the shock model of Kennel and Sagdeev therefore is forbidden. Numerical solutions using typical solar wind conditions show that finite concentrations of alpha particles have no significant effect on the dispersion (negative) but introduce new cutoff and resonant frequencies, as well as a band of evanescence just above the alpha particle gyrofrequency. Finite temperature also introduces resonances and cutoffs at harmonics of the ion gyrofrequencies. (auth)

5174 DYNAMICS OF A CHARGED PARTICLE IN A SPIRAL FIELD. Burns, Joseph A.; Halpern, Gerald (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 7377-84 (Dec. 1, 1968).

The adiabatic guiding center motion of an energetic charged particle in an idealized representation of the interplanetary magnetic field is discussed. Expressions are presented for all drift velocity components. A comparison of these drifts establishes that, for the cases of physical interest, the electric drift velocity is by far the dominant drift velocity. Considering only the electric drift velocity, an expression is derived for the time of flight of a particle leaving the Sun. Similarly, it is shown analytically that the particles remain attached to the same field line on which they left the Sun, thus indicating their point of origin. High-energy unscattered particles are shown to be rapidly channeled down the field lines, which results in a highly anisotropic particle distribution in the vicinity of the Earth. These analytic results are in excellent agreement with numerical integration of the complete drift equation and compare favorably with the experimental data. (auth)

5175 PROPERTIES OF SOLAR WIND TURBULENCE DEDUCED BY RADIO ASTRONOMICAL MEASUREMENTS. Hollweg, Joseph V.; Harrington, J. V. (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 73: 7221-30(Dec. 1, 1968).

A simple ray analysis was used to derive expressions for the angular spread and spectral broadening of coherent radio signals on traversing the turbulent interplanetary medium, when the anisotropy and radial gradient of the turbulence and the large-scale motions of the medium (solar wind) are important. The resulting expressions were used to interpret observations, re-

ported in the literature, of the angular broadening of natural radio sources and of the spectral broadening of Mariner 4 during superior conjunction. In the region 10 to 100 solar radii the results are consistent with a coronal electron concentration behaving as r^{-2} and a statistical correlation length which during solar minimum does not vary with r but which tends to increase linearly with r near solar maximum, indicating that the interplanetary plasma tends to develop a radial filamentary structure during solar maximum; no necessity was found to invoke nonradial outflow to explain the observations. In the region 3 to 6 solar radii the data imply $a^2/b \sim r^3$, where a is the correlation length in the radial direction and b is the correlation length in the transverse direction. It is pointed out that this behavior can result if both the transverse correlation length and the anisotropy ratio, a/b, increase linearly with r in that region. (auth)

5176 SOLAR ROTATION AND NEUTRINO FLUX. Shaviv, G.; Salpeter, Edwin E. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 21: 1602-5(Dec. 2, 1968).

If the Sun possesses a fast-rotating core, mixing in its interior may be a possibility. The solar neutrino flux is calculated as a functional mass q_m in the mixed zone for "slow," "fast," and "very fast" mixing. Only for "slow" mixing and large q_m could the neutrino flux be decreased appreciably, but such large values of q_m are unlikely. (auth)

5177 POSSIBLE MECHANISM FOR PRODUCING SUNSPOT MAGNETIC FIELDS. Getling, A. V.; Tverskoi, B. A. (Moscow Univ.). Sov. Astron. AJ (Engl. Transl.), 12: 481-3(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 606-9(May-June 1968).

A model is suggested for a local hydromagnetic mechanism capable of strengthening magnetic fields and of imparting to them a configuration typical of that for bipolar sunspot groups. An eddy ring in a conducting fluid would possess these properties, under certain general assumptions (closed streamlines would be "strung" along the ring, forming the surface of an arbitrarily distorted torus). The field harmonic describing the main structural features of the field will essentially preserve its spatial distribution. The applicability of the model to the conditions prevailing in the solar atmosphere is discussed. (auth)

5178 LONGITUDE DEPENDENCE OF THE DEGREE OF POLARIZATION OF TYPE III SOLAR RADIO BURSTS. Fomichev, V. V.; Chertok, I. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 477-80(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 601-5(May-June 1968).

The heliographic-longitude dependence of the degree of polarization of type-III bursts is considered. The curve for the longitude dependence of the mean degree of polarization has a characteristic shape, with two maxima near 30° on the east side of the disk and 40° on the west side, and a minimum at a longitude of ~10° west of the central meridian. The enhanced polarization of bursts at these longitudes results from the increased proportion of strongly polarized bursts there. This type of longitude dependence for the degree of polarization, as well as the distribution over the disk of strongly and weakly polarized bursts (corrected for the eastward inclination of active regions) agrees with an interpretation in which the polarization is regarded as arising from the effects of the conditions experienced by radio waves as they travel through and emerge from the solar corona. (auth)

5179 THE 1.6-cm RADIO EMISSION OF SOLAR SOURCES ASSOCIATED WITH SUNSPOTS AND FLOCCULI. Grebinskii, A. S.; Man'ko, V. I.; Yasnov, L. V. (Leningrad State Univ.). Sov. Astron. AJ (Engl. Transl.), 12: 473-6(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 597-600(May-June 1968).

The results are reported of observations of sources associated with sunspot groups and flocculi, as carried out at wavelength $\lambda = 3.6'$ cm with the RT-22 radio telescope, having a pencil beam of width $\varphi = 3.6'$. A portion of the flux from strong sources is found to vary over a period of several hours, possibly because of fluctuations in the sunspot magnetic field at the photospheric level, as well as microflares. The flux from the sources appears to be smaller at $\lambda = 1.6$ cm than at $\lambda = 3.2$ cm. At $\lambda = 1.6$ cm sources above isolated flocculi are observed to brighten as they move toward the limb of the disk. (auth)

5180 THEORY OF THE SLOWLY CHANGING COMPONENT OF SOLAR RADIO EMISSION. II. Zlotnik, E. Ya. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 12: 464-72(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 585-96(May-June 1968).

Within the framework of a model of an active region the author examines the characteristics of slowly changing solar radio emission caused by the joint effect of the bremsstrahlung and synchrotron mechanisms. It is shown that the adopted generation model explains the principal characteristics of the s component: radio brightness distribution over the source, characteristic frequency spectrum with a maximum at wavelengths 6–12 cm, dependence of polarization on wavelength, change in dimensions and altitude of the source with frequency, character of the directivity of radiation, and relationship to the optical characteristics of activity centers. The relative role of the two mechanisms in total radiation is clarified: bremsstrahlung is decisive in the short-wave part of the centimeter range ($\lambda < 5$ cm) and at decimeter wavelengths ($\lambda < 15$ cm), whereas the synchrotron mechanism makes its basic contribution in the range 6 cm $< \lambda <$ 12 cm, where the frequency spectrum has a maximum. The adopted model of a local source is discussed in detail. Methods making it possible to judge the physical conditions (temperature, plasma concentration, magnetic field) in active regions on the Sun from the known characteristics of the s component are indicated. (auth)

Galaxies

Refer also to abstracts 5152 and 5259.

5181 SPECTROGRAPHIC STUDY OF THE SEYFERT GALAXY NGC 3227. Rubin, Vera C.; Ford, W. Kent Jr. (Carnegie Institution of Washington, D. C. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 154: 431-45 (Nov. 1968).

Image-tube spectra of the Seyfert galaxy NGC 3227 were obtained at a dispersion of 132 Å mm^{-1}, centered near Hα. Broad emission lines of Hα, Hβ, [O(III)] λλ4959, 5007, [O(I)] λλ6300, 6364, [N(II)] λλ6548, 6583 were observed; a G-type absorption-line spectrum was also present. Measured velocities of the broad emission lines in the nuclear region ($r < 200$ pc) indicate that discrete gas clouds are moving with velocities which range over several thousand kilometers per second. These clouds have a mean negative velocity with respect to the central velocity due to the motions of clouds expanding from the nucleus. Line strengths were determined, and mean values of T and N_e calculated. In the disk of NGC 3227, sharp lines of Hα and [N(II)] were observed, which give a linear rotation curve out to $r = 600$ pc. Emission was also observed at $r = 3900$ pc and in the connecting arm between NGC 3227 and its elliptical companion, NGC 3226; this gas has a velocity of -700 km sec^{-1} with respect to the mean NGC 3226/3227 velocity. The spectrum of the elliptical companion NGC 3226 has emission lines of Hα, [N(II)] λλ6548, 6583, and Hβ. (auth)

5182 NATURE OF THE OPTICAL FLUX FROM EXTRAGALACTIC SYSTEMS. Grewing, Michael; Demoulin, Marie-Helene; Burbidge, G. R. (Univ. of Bonn, Univ. of California, San Diego). Astrophys. J., 154: 447-74(Nov. 1968).

Optical radiation from galaxies may have components of three different kinds. It may be starlight, flux generated by nonthermal processes, or radiation from a hot gas. Detailed calculations of the flux from these different components and the energy distributions to be expected from combinations of them were made. In the case of starlight it was assumed that the stellar population is similar to that of giant elliptical galaxies. The nonthermal flux was calculated for a number of assumed power-law spectra. In the case of radiation from a hot gas, both continuum and emission lines were calculated for a temperature range of 6000 to 50,000°K and for two values of the ratio of photon density to electron density, 1 and 10^{-4}. The intensities of the strong emission lines are given. From the energy distributions computed or assumed for the three components, the UBV colors were calculated for a large range of possible combinations and for red shifts from $z = 0$ to $z = 1$. The results are given in K-corrections for the three components for the same range of red shifts are given. A detailed comparison is made between the observed colors of Seyfert galaxies, N-type galaxies, and some radio galaxies. While in some cases the data are adequate to sort out the relative importance of different components, the main conclusion is that, on the basis of red shifts and colors alone, it will be difficult to distinguish between the components in galaxies where outbursts have occurred. Finally it is shown that dust, which is known to be present in some radio galaxies, may have a significant effect on the colors. Thus one possibility is that a major part of the flux from some radio galaxies could be nonstellar radiation reddened by interaction with dust. Observational programs which might resolve some of the ambiguities are briefly discussed. (auth)

5183 TWO-DIMENSIONAL CLASSIFICATION FOR GALACTIC GLOBULAR CLUSTERS. Hartwick, F. D. A. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 154: 475-81(Nov. 1968).

It is shown that all of the galactic globular clusters with available C–M diagrams fit into a two-dimensional classification with helium and heavy-element abundance as the two parameters. The

classification, which is based on the cluster's position in the $S_1(B-V)_{og}$ plane, results in systematic changes in the character of the horizontal branch from group to group. Satisfactory agreement in interpretation is found from the limited theoretical models available. (auth)

5184 THE DYNAMICAL STATE OF THE INTERSTELLAR GAS AND FIELD. VI. INSTABILITY AND ENHANCED DIFFUSION IN A TWISTED FIELD. Lerche, I.; Parker, E. N. (Univ. of Chicago). Astrophys. J., 154: 515-31(Nov. 1968).

The general instability of a magnetic field confined by the weight of thermal gas (through which the field threads) was investigated for a twisted field ($\nabla \times B \parallel B$). The purpose was to see whether the associated enhanced ambipolar diffusion is seriously affected by the twist in the field. It was pointed out earlier that the enhanced diffusion (computed for an untwisted field) may contribute (a) to the escape of the interstellar magnetic field from the gas forming a star and (b) to the evolution of the gaseous disk of the Galaxy. The calculations given in the present paper suggest that the twist in the field should increase the instability and the associated large wave numbers, thereby increasing the enhanced ambipolar diffusion. It is concluded that earlier estimates of the enhanced ambipolar diffusion rate in the Galaxy may be on the conservative side. (auth)

5185 DEGREE OF CENTRAL CONCENTRATION OF MASS IN SPIRAL GALAXIES. Sharpless, Stewart; Franz, Otto G. (Univ. of Rochester, N. Y. Lowell Observatory, Flagstaff, Ariz.). Astrophys. J., 154: 789-91(Nov. 1968).

This note examines the question of whether a parallel correlation exists between the spectral type of a galaxy on the Morgan–Mayall system and the degree of central concentration of mass as determined by computations similar to those of Crampin and Hoyle (1964). (W.D.M.)

5186 REDDENING IN THE NUCLEI OF SEYFERT GALAXIES. Wampler, E. Joseph (Univ. of California, Santa Cruz). Contract NSR 05-003-100. Astrophys. J., 154: L53-6(Nov. 1968).

A comparison of infrared with violet line intensities shows that substantial reddening exists in the nuclei of Seyfert galaxies. (auth)

5187 CONTRIBUTION OF INFRARED GALAXIES TO THE COSMIC BACKGROUND. Low, Frank J. (Rice Univ., Houston, Tex. Univ. of Arizona, Tucson); Tucker, Wallace H. Phys. Rev. Lett., 21: 1538-41(Nov. 25, 1968).

The far-infrared background due to a superposition of infrared galaxies of the type recently observed is computed. It is shown that these galaxies contribute an amount of energy to the universe roughly equal to that radiated by the other galaxies and produce a far-infrared background peaking beyond 50 μ. It is likely that they account for most of the observed extragalactic radio background but not the 3°K microwave background. (auth)

5188 VARIABLE GALAXIES. Kinman, T. D. (Univ. of California, Santa Cruz). Science, 162: 1081-5(Dec. 6, 1968).

Discovery of variable galaxies, programs for observing variable galaxies, light curves of some variable galaxies, and interpretation of the variations are discussed. The word galaxy is used in the very broad sense to cover objects which are outside the Milky Way (and unlike any objects within it) and which show some similarities in their properties. (W.D.M.)

5189 OCCULTATIONS OF THE GALACTIC CENTER REGION IN THE 1667-MHz OH LINE. Kerr, F. J.; Sandqvist, A. (Univ. of Maryland, College Park). Astrophys. Lett., 2: 195-200(Dec. 2, 1968).

A series of lunar occulations of the galactic center region is being observed on the NRAO 140-foot telescope in the 18- and 21-cm lines. A preliminary study of the first two events at 1667 MHz indicates that the +40 km/sec component of the OH absorption originates in a cloud of dimensions 3 × 5 arc min which appears to rotate as a uniform body. Internal structure of the order of 30 arc sec has been detected in the −130 km/sec component. (auth)

5190 RADIO FREQUENCY SPECTRA OF NGC 1052 AND NGC 4278. Wills, D. (Cambridge Univ., Eng.). Astrophys. Lett., 2: 187-90(Dec. 2, 1968).

The 178 MHz flux density of NGC 1052 is much higher than the value expected by extrapolation from higher frequencies, suggesting a two-component source model. Absorption of the radiation from the high-frequency component is probably due to synchrotron self-absorption, although thermal absorption cannot be ruled out. The upper limit to the 178-MHz flux density of NGC 4278, combined with higher-frequency results, suggests that thermal absorption of radiation from a nonthermal source is responsible for the shape of the spectrum. (auth)

5191 GRAVITATION STABILITY OF ROTATING ANISOTROPIC STELLAR SYSTEMS. Marochnik, L. S.; Ptitsina, N. G. (Inst. of Astrophysics, Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 411-19(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 516-27(May-June 1968).

The problem of the behavior of small perturbations arising in an unbounded, rotating, anisotropic stellar system that is homogeneous along its rotation axis is treated on the basis of the Boltzmann equation for the stellar-velocity distribution function without the collision term and the Poisson equation for the gravitational potential. A critical wavelength λ_{cr} separates stable from unstable perturbations. The unstable perturbations ($\lambda > \lambda_{cr}$) grow aperiodically (gravitational contraction). The stable perturbations ($\lambda < \lambda_{cr}$) are damped out if they travel close to the rotation axis ($\theta \sim 0$). Undamped waves can exist in a stellar system near a plane perpendicular to the rotation axis ($\theta \sim \pi/2$). These waves are of the same character as Lin and Shu's spiral waves (propagated through "Coriolis elasticity"), with which they probably coincide in the case of nonaxisymmetric perturbations. In an isotropic stellar system as well as in a continuous medium rotation would have no effect on the Jeans instability criterion (for $\theta = \pi/2$). In an anisotropic system the Jeans criterion is violated for $\theta \neq \pi/2$, with λ_{cr} depending strongly on the angular rotational velocity and the anisotropy. For $\theta = \pi/2$ the critical wavelength does not depend on the anisotropy but it differs from the corresponding λ_{cr} calculated by Chandrasekhar for a continuous medium. (auth)

5192 DWARF COMPANIONS OF GALAXIES NOTED IN THE MORPHOLOGICAL CATALOG OF GALAXIES. Zvyagina, E. V. (State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 406-10(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 510-15(May-June 1968).

If the apparent distribution of galaxies on the Palomar Sky Atlas charts is assumed to follow the Poisson law, the maximum percentage of optical pairs in the "Morphological Catalog of Galaxies" having a large difference in apparent magnitude can be estimated. At least one-half the companions with $\Delta m \geq 2.5$ are found to be physical companions out to an angular distance $\rho = 0'.5$ from galaxies of apparent magnitude m = 16 and 15, and to $\rho = 1'.5$ from brighter primary components. (auth)

5193 GLOBULAR CLUSTER M 13 AND FIELD STARS. Kadla, Z. I. (Main Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.), 12: 429-39(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 541-55(May-June 1968).

The results obtained are based on the proper motions and the UBV data of the field stars and members of the globular cluster M 13 in an area of 80′ × 80′. The UBV diagrams for the members of the cluster (μ,Φ) stars, i.e., those which satisfy the adopted proper motion and photometric criteria, show that the majority of giants with $B-V > +1.05$ are concentrated into an area with radius $r < 4'.0$, where r is the distance from the center of the cluster. The blue "stragglers" appear to be concentrated within an area with $r < 4'.0$; however, more accurate data are needed for them. The radius of the cluster for the members brighter than 16.0^m is equal to $16'.2$. In the zone $4'.0 \leq r \leq 16'.2$ no blue "stragglers" were detected. Beyond these limits three (μ,Φ) stars were found and one blue "straggler" with $B-V < 0.00$. Proper motion diagrams for 221 field stars with $13.5 \leq V < 15.5$, $+0.33 \leq B-V \leq +0.80$, and $\overline{\delta(U-B)} = 0.00, +0.13, +0.26$ are compared. The stars which show an ultraviolet excess can be divided into two groups. One group, comprising about 8% of the stars investigated with $\delta(U-B) > +0.06$, consists of high velocity stars. The kinematic characteristics of the stars of the second group are similar to those of MS stars and depend on their distance from the galactic plane. A preliminary attempt to estimate the amount of interstellar absorption on the basis of spectroscopic data for B8-A7 field stars, using derived spectrophotometric gradients and M_V, indicates that $A_V = 0.48$. This result will be made more precise in the future on the basis of UBV data. (auth)

5194 RADIO EMISSION SPECTRA OF RADIO GALAXIES. Kuril'chik, V. N.; Lekht, E. E. (State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 12: 386-8(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 485-8(May-June 1968).

The latest data on radio power flux density measurements are utilized in a study of the radio emission spectra of objects listed in the 3CR catalog and identified with radio galaxies. A histogram of the relationship between the number N of radio galaxies and the spectral index α is plotted, revealing the typical feature of two sharply defined maxima. The first maximum characterizes radio emission spectra corresponding to the energy spectra of relativ-

istic electrons pumped out from regions where they were accelerated (galactic nuclei) to the extended regions where they give rise to synchrotron radiation at radio frequencies. The second peak results from transformation of the pumped spectra through synchrotron losses of the energy associated with the relativistic electrons at pumping conditions close to quasi-stationary. (auth)

Cosmology

Refer also to abstract 5972.

5195 RELATIVISTIC STOCHASTIC PROCESSES. Hakim, Remi (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). J. Math. Phys. (N. Y.), 9: 1805-18(Nov. 1968).

Relativistic stochastic processes in μ space are defined and studied in a completely (and manifestly) covariant manner, without particularizing the time variable. It is shown that a number of usual definitions such as "Gaussian process," etc., cannot be given a fully invariant meaning. Markovian processes are also studied. As a particular case, results already obtained by Lopuszahski [Acta Phys., Polon., 12: 37(1953)] in the case of Markovian processes in Minkowski space–time are found anew. Several suggestions are made to generalize these results. (auth)

5196 THEORY OF EVOLVING UNIVERSE BASED UPON METRICAL CONSIDERATIONS OF SPACE, TIME, AND MASS. Kuronuma, Eiichi (Yamagata Univ., Japan). Yamagata Daigaku Kiyo, Shizenkagaku, 7: 15-28(Jan. 1968).

An attempt is made to harmonize the Einstein theory of gravitation with the Newtonian theory by proper use of the two kinds of measuring units (natural Einsteinian and absolute Newtonian). A new parameter, called cosmic potential Φ is introduced which indicates the structure of the vacuum space. The relation of Φ to the Newtonian potential ϕ is established. An energy tensor comprising both matter and field is introduced and the equation of motion is given that is valid outside as well as inside the field source. The evolution of the Universe is discussed on the basis of the exact solution of Einstein's equations of gravitation. The red shift of spectral lines is explained not as the Doppler effect but as a proof of this evolution. In conclusion an outline of the unified metrical field theory is given. (IAA)

5197 TEORIYA POLYA. (Field Theory). Landau, L. D.; Lifshits, E. M. Teoreticheskaya Fizika. Tom II. Moscow, Izdatel'stvo Nauka, 1967. 460p.

The theory of electromagnetic and gravitational fields is discussed mostly within the framework of microscopic electrodynamics (vacuum and point charge electrodynamics) and considering the theory of relativity as the basis. The book consists of twelve chapters. The first six chapters cover: principles of the theory of relativity, relativistic mechanics, charge in electromagnetic fields, equations for electromagnetic fields, constant electromagnetic fields, and electromagnetic waves. The next three chapters deal with light diffusion, field of moving charges, and electromagnetic wave radiation. Gravitational fields, particles in gravitational fields, gravitational field equations, and relativistic cosmology are covered in the last three chapters. (R.V.J.)

5198 EXPECTED ANISOTROPY OF COSMOLOGICAL RADIO EMISSION IN HOMOGENEOUS ANISOTROPIC MODELS. Novikov, I. D. Sov. Astron. AJ (Engl. Transl.), 12: 427-8(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 538-40(May–June 1968).

The sky distribution of intensity of 3°K cosmological radio emission in homogeneous anisotropic cosmological models with a flat space is known to have a quadrupole nature. It is demonstrated here that the distribution of intensity of cosmological radio emission in anisotropic homogeneous models with a space other than flat deviates from the quadrupole distribution and can be presented in the form $\Delta T/T \approx f(\theta) \sin 2\varphi$, where the function $f(\theta)$ exhibits a sharp peak at some $\theta_0 \ll 1$ and is almost zero at all other θ values. (auth)

Planetary Phenomena

5199 RADIOMETRIC OBSERVATIONS OF THE PLANETS JUPITER, VENUS, AND MARS AT A WAVELENGTH OF 8.6 mm. Kalaghan, P. M.; Wulfsberg, K. N. (Hanscom Field, Bedford, Mass.). Astrophys. J., 154: 771-3(Nov. 1968).

Observations of the 8.6-mm radio emission from the planets Jupiter, Venus, and Mars are reported. Average disk temperatures of 142 (+14, −10)°K for Jupiter, 423 (+42, −30)°K for Venus over the 51 to 62° phase angle range, and 235 (+40, −33)°K for Mars were obtained. Comparisons with previously reported data are made. (auth)

5200 RADIOMETRIC MEASUREMENTS OF THE MOON AT 8.6- AND 3.2-MILLIMETER WAVELENGTHS. Clardy, D. E.; Straiton, A. W. (Univ. of Texas, Austin). Astrophys. J., 154: 775-87(Nov. 1968).

Lunar thermal-radiation data were recorded at wavelengths of 8.6 and 3.2 mm with a 16-foot-diameter antenna system at Austin, Texas. The data provided contours of equal brightness temperatures over the lunar disk at intervals of approximately 24° in lunar phase angle. Variations of brightness temperature with time are presented in curves and as Fourier components for the selenographic center, the area around Surveyor I, Mare Tranquillitatis, Mare Imbrium, Copernicus, and the highland area around 10° W., 20° S. Comparison is made with similar measurements made with antenna beams 12′ or less. (auth)

5201 THEORY OF THE RADIO EMISSION OF MERCURY. Vetukhnovskaya, Yu. N.; Kuz'min, A. D. (Inst. of Physics, Moscow). Astron. Vestn., 2: 65-71(Apr.–June 1968. (In Russian).

The brightness temperature of Mercury was calculated as a function of the thermal and electrical parameters of its surface, the phase of the illumination of the planet by the Sun, and its distance from the Sun. The calculated results are found to be in agreement with the experimental data reported by Kaftan–Kassim and Kellerman (1967) for a wide range of surface parameters, including those of the lunar surface. (IAA)

5202 INTRINSIC MAGNETIC PROPERTIES OF THE LUNAR BODY. Behannon, Kenneth W. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 7257-68(Dec. 1, 1968).

Reversal of the ambient tail field by 180° when the Moon and Explorer 35 in lunar orbit traverse the neutral sheet permits a separation of permanent and induced field contributions to the total field observed near the Moon. When compared with calculated permanent and induced field effects, the results of this analysis lead to new upper limits of 10^{20} gauss cm^3 on the lunar magnetic moment and 4 γ on the lunar surface field. Limiting the moment induced in the Moon by the magnetotail field permits an upper limit of 1.8 to be set on the bulk relative magnetic permeability of the Moon. (auth)

5203 DRIFT PATTERNS IN THE DYNAMIC SPECTRA OF JUPITER'S DECAMETRIC RADIATION. Riihimaa, J. J.; Warwick, J. W. (Univ. of Colorado, Boulder). Astrophys. Lett., 2: 185-6(Dec. 2, 1968).

Study of high-resolution records of Jupiter's radiation, made with spectral equipment at Arecibo, confirms the existence of regular drift patterns in the spectral fine structure of decasecond bursts. (auth)

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Refer also to abstracts 4629, 5110, 5131, 5485, 5571, 5962, and 5965.

5204 (JPRS–45278) PHOTOCONDUCTIVITY AND QUANTUM YIELD IN GERMANIUM UNDER THE ACTION OF ROENTGEN RADIATION. Kamoldinov, M. G. Translated from Izv. Vyssh. Ucheb. Zaved., Fiz., No. 3, 22-6(1967). 8p. CFSTI.

An abstract for the original article appeared previously in NSA 21: 40082. (M.O.W.)

5205 (ORO–2591-35) A LISTING OF PUBLICATIONS CONCERNING THE FORMATION AND DESTRUCTION OF EXCITED STATES BY COLLISIONS BETWEEN ATOMIC SYSTEMS. Technical Report No. 2. Thomas, E. W. (Georgia Inst. of Tech., Atlanta. School of Physics). Aug. 31, 1968. Contract AT(40-1)-591. 48p. Dep. CFSTI.

Sources of experimental data on the formation and destruction of excited states by atom–atom and ion–atom collisions at impact energies greater than 10 eV are listed. The list is divided into four sections as follows: (1) formation of excited atoms and ions by collision between two ground-state atomic or molecular structures under single-collision conditions; (2) differential scattering associated with the formation of an excited state; (3) collisional quenching of excited states under single-collision conditions; and (4) formation of excited states in a particle beam traversing a gas cell or plasma under multiple-collision conditions. Each section includes a tabulation of reactants, range of impact energy, assessment of data accuracy, and references. The compilation is believed to be complete to July 1, 1968. (A.G.W.)

5206 (ORO–2591-37) EMISSION AND EXCITATION CROSS SECTIONS. Progress Report No. 4, December 1, 1967–November 30, 1968. Thomas, E. W.; Edwards, J. L.; Ford, J. C. (Georgia Inst. of Tech., Atlanta, School of Physics). Contract AT(40-1)-2591. 23p. Dep. CFSTI.

Progress is reported on a study of the formation of fast excited H atoms by impact of H^+, H_2^+, or H_3^+ ions on He and N_2 at projectile energies ranging from 0.15 to 1 MeV. Attention is restricted to the formation of the 3s, 3p, and 3d excited states of hydrogen. Particular attention is given to errors that might be introduced by weak-field Stark effects and to problems due to the Doppler shift of the Balmer-α emission. Results are presented for the relative values of the cross sections for charge transfer into the 3s, 3p, and 3d states of hydrogen at 150 and 350 keV. A preliminary survey indicates that cross sections for forming excited H by dissociation of H_2^+ and H_3^+ by impact on He and N_2 targets are many orders of magnitude greater than those for the charge-transfer process. (A.G.W.)

5207 A COMPARATIVE STUDY OF THE ENERGY DISTRIBUTION OF SECONDARY ELECTRONS AND PHOTOELECTRONS EXCITED BY SOFT X RAYS. Nakhodkin, N. G.; Mel'nik, P. V. (Kiev State Univ.). Sov. Phys.-Solid State (Eng. Transl.), 10: 1462-4(Dec. 1968).

Translated from Fiz. Tverd. Tela, 10: 1859-62(June 1968).

A comparative study is made of the energy spectra of photo- and secondary electrons of gold and germanium films deposited in a vacuum for the same energies of the primary electrons E_p and x rays $h\nu$ ($h\nu$ = 1.5 to 8 keV). In addition to the Auger electrons, one observes a group of electrons from the various levels of the target atoms in the energy spectra of the x-ray photoemission. It turns out that the Auger processes play a more important role in the x-ray photoeffect than in the secondary electron emission phenomenon. It is also shown that the energy spectra for photoelectrons from thick targets are very much broadened because of inelastic scattering of fast photo- and Auger electrons. (auth)

5208 SPIN–ORBIT INTERACTIONS OF THE CONFIGURATION $l^{n-1}l'l''$. Roth, Charles (McGill Univ., Montreal). J. Math. Phys. (N. Y.), 9: 1832-4(Nov. 1968).

Matrix elements for the spin–orbit interactions of the configuration $l^{n-1}l'l''$ in L–S coupling are expressed as linear combinations of radial integrals. (auth)

5209 BAND OSCILLATOR STRENGTHS OF THE LYMAN SYSTEM OF MOLECULAR HYDROGEN. Dalgarno, A.; Allison, A. C. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astrophys. J., 154: L95-7(Nov. 1968).

Theoretical oscillator strengths are presented for all the bands of the Lyman system of molecular hydrogen produced by absorption from the lowest vibrational level of the ground electronic state. (auth)

5210 USE OF PSEUDOPOTENTIALS IN ATOMIC-STRUCTURE CALCULATIONS. Weeks, John D.; Rice, Stuart A. (Univ. of Chicago). J. Chem. Phys., 49: 2741-55(Sept. 15, 1968).

It is felt by the authors that the ideas of pseudopotential analysis can be usefully applied to the removal of orthogonality constraints in a wide class of problems. A generalization of the method of pseudopotentials applicable to many-electron systems is described. The generalized pseudopotential derived reduces to the Phillips–Kleinman pseudopotential under the one-electron Hartree–Fock approximation, and a study of its structure helps to clarify some of the properties of one-electron pseudopotentials. The generalized formalism is then applied to ions with one valence electron, such as Be^+ and Mg^+, where it suggests a simple model potential that gives a good description of the Rydberg spectra of these ions. The relationship of the pseudopotential to the model potential is discussed. The theory is then applied to atoms with two valence electrons, such as Be and Mg, and it is shown how the use of one-electron pseudopotentials or model potentials can simplify, for example, the "exact pair" equations describing the motion of the valence-electron pair in the Hartree–Fock sea and permit the removal of orthogonality constraints on the pair wave function. Good results are obtained in calculations of the valence-pair energy of Be and Mg. Further approximations are discussed which allow calculation of the valence-pair energy when the core orbitals are not known. The approximate methods are applied to Be, Mg, and Sr with good results. (auth)

5211 NEW TYPE OF MONOVELOCITY ELECTRON SOURCE. Marmet, Paul (Univ. of Laval, Quebec). Rev. Sci. Instrum., 39: 1932-6(Dec. 1968).

A new instrument is calculated which makes possible the transformations of an electron beam of wide energy spread into an intense monovelocity beam suitable for electron impact work. Only the most promising models are calculated and the predicted results raise the possibility of producing intense beams of monovelocity-electrons in a nonfield-free region, consequently reducing noise and secondary reactions. (auth)

5212 CONDENSED-STATE EFFECTS IN PIONIC AND MUONIC X-RAY SPECTRA. Tauscher, L. (CERN, Geneva. Max-Planck-Institut fuer Kernphysik, Heidelberg); Backenstoss, G.; Charalambus, S.; Daniel, H.; Koch, H.; Poelz, G.; Schmitt, H. Phys. Lett., 27A: 581-2(Sept. 23, 1968).

Intensity measurements of pionic and muonic x-rays in targets of different physical or chemical composition are reported. (auth)

5213 METASTABLE ATOMS AND MOLECULES. III. METASTABLE IMPACTS ON SURFACES WITH VARIOUS WORK FUNCTIONS. Varney, R. N. (Lockheed Palo Alto Research Lab., Calif.). Phys. Rev., 175: 98-102(Nov. 5, 1968).

Surfaces of atomically clean tungsten with work function 4.5 eV, tungsten oxidized with a monolayer of oxide and having a work function 6.6 eV, and tungsten coated with BaO with a work function probably under 2 eV were hit by metastable atoms or molecules of Ar, Xe, N_2, and H_2. The emission of secondary electrons by metastable atoms and the surface ionization of the atomic metastables were shown to follow the expected dependency on the work function. The N_2 molecular metastable were weakly surface ionized as N_2^+ on the oxidized tungsten but not on the surfaces of lower work function. Secondary electron emission either did not occur at all or was obscured by the large emission of CN^- negative ions. No CN^- emission nor electron emission was observed on the W–O surface. Metastables of H_2 dissociated on the clean and the oxidized surfaces. On the clean surface, one atom became H(2p) and gave out Lyman alpha radiation. On the W–O surface, one of the H atoms became a proton and no Lyman alpha radiation was produced. No other ion emission than H^+ occurred. (auth)

5214 g_J FACTORS OF THE 6s6p $^3P_1$ AND 6s6p $^1P_1$ STATES OF YTTERBIUM. Baumann, M.; Wandel, G. (Univ., Tuebingen, Ger.). Phys. Lett., 28A: 200-1(Nov. 18, 1968).

The $g_J(^3P_1)$ and $g_J(^1P_1)$ factors of the (6s6p) configuration have been determined in an optical double resonance experiment. The results are $g_J(^3P_1) = 1.49285(5)$, $g_J(^1P_1) = 1.035(5)$. (auth)

5215 PHOTOIONIZATION CROSS SECTIONS OF THE ELEMENTS HELIUM TO XENON. McGuire, Eugene J. (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 175: 20-30(Nov. 5, 1968).

The quantity $-rV(r)$ calculated by Herman and Skillman, using the Hartree–Fock–Slater approach, is approximated by a series of straight lines. With such a potential the radial Schroedinger equation is exactly solvable with Whittaker functions. The bound-state eigenvalue equation is found and is used to adjust the parameters of the straight lines so that the model eigenvalues and those of Herman and Skillman are in reasonable agreement. With the discrete and continuum orbitals of the model, the photoionization cross section for all the shells of the elements helium through xenon are computed. (auth)

5216 CONFIGURATION INTERACTION THEORY. EFFECTS OF OVERLAPPING RESONANCES. Mies, Frederick H. (National Bureau of Standards, Washington, D. C.). Phys. Rev., 175: 164-75(Nov. 5, 1968).

Fano's resonance theory has been extended to include the interaction of many resonances with many continua and inelastic couplings between continuum states. In particular a new parameter has been introduced; the overlap matrix between the continua to which neighboring resonances are coupled. Resonances which are coupled to the same channel states may be said to overlap. If their widths are comparable to their spacings the resultant effects on photoabsorption or on the scattering matrix can be quite profound. The apparent widths may bear little relation to the widths due to configuration interaction, and the resultant structure may not fit the usual Fano–Buetler profiles for isolated resonances. The effects of overlapping have been examined for various models which are representative of atomic photoabsorption and electron–diatomic molecule scattering. It is demonstrated that without prior knowledge of the overlap matrix it is impossible to uniquely characterize a resonance from limited experimental observations. Scattering and photoabsorption experiments should be designed to examine all possible channels, i.e., both differential and inelastic cross sections. Even so, without the parallel support of theoretical estimates of partial widths, and the signs of the configuration interaction matrix elements, the interpretation of resonance phenomena and in particular the parameters which are extracted must be accepted with severe reservations. (auth)

5217 INFLUENCE OF Q VALUES IN ATOMIC SINGLE COLLISIONS ON OBSERVED SCATTERING CROSS SECTIONS AND SOME Q VALUES. Loftager, P.; Hermann, G. (Univ. of Aarhus, Denmark). Phys. Rev. Lett., 21: 1623-6(Dec. 9, 1968).

Total differential scattering cross sections observed at 80° in the lab system versus incident energy for 12- to 100-keV P^+, Cl^+, Ar^+, and K^+ on Ar exhibit a similar characteristic structure. The

structure is explained in terms of the kinematics of inelastic collisions occurring in the region of triple Q structure in the Ar–Ar case. The existence of triple Q structure in P^+–, Cl^+–, and K^+–Ar cases is further supported by a calculation of Q values involving theoretical Thomas–Fermi cross sections. (auth)

5218 SCATTERING OF HIGH-ENERGY ALKALI ATOMS. Cross, R. J. Jr.; Malerich, C. J. (Yale Univ., New Haven). Chem. Phys. Lett., 2: 481-2(Nov. 1968).

Total collision cross sections were measured for K–Ar, K–Xe, and K–CH_3I in the lab energy range of 6 to 1000 eV. The measurements were compared to theoretical cross sections (which include the effects of apparatus resolution) for a Lennard-Jones (6,n) potential. The best value of n was 7, but the fit was poor indicating that the Lennard-Jones potential is not a good potential. (auth)

5219 CROSS SECTION FOR DEORIENTATION OF MERCURY ATOMS IN METASTABLE 6^3P_2 STATES BY COLLISIONS WITH RARE GASES. Baumann, M.; Eibofner, A. (Univ., Tuebingen, Ger.). Z. Naturforsch., 23a: 1409-10(Sept. 1968). (In German).

The cross sections for the deorientation of mercury atoms in the metastable 6^3P_2 state by collision with He, Ne, Ar, Kr, and Xe were measured. The 6^3P_2 level, which is split in a static magnetic field into five Zeeman terms, was excited from the 6^1S_0 ground state by electron collision. The Zeeman levels were unsymmetrical so that an alignment of the 6^3P_2 level was attained. The cross sections measured agree within the limits of error with the previous measurements of Tittel, but they are systematically higher than the results of Casalta et al. (J.S.R.)

5220 AUGER IONIZATION INDUCED BY MULTICHARGED IONS. Kishinevskii, L. M.; Parilis, E. S. (Inst. of Electronics, Tashkent). Zh. Eksp. Teor. Fiz., 55: 1932-42(Nov. 1968). (In Russian).

In collisions between a multi-charged ion and an atom, Auger ionization occurs in which an atom electron is captured by the ion and another electron is emitted at the expense of the liberated energy. Ionization may proceed along three channels: directly (I), after preliminary single charge exchange (II), or after double charge exchange (III). In the present paper an attempt is made to estimate Auger ionization for each of the channels, their relative contribution to the total Auger ionization cross section and also the dependence on ion charge and velocity. In all cases the cross section is found to be of the order of 10^{-16} to 10^{-15} cm^2. The Auger electron energy spectrum and ion scattering in each of the channels are discussed. Earlier experiments in which additional ionization was observed in collisions between Ne^{3+} or Ne^{4+} and Xe are analyzed. Other pairs of atoms and multi-charged ions for which the phenomenon should be observable are indicated as well as the velocity range in which it is most effective. (auth)

5221 SOME FEATURES OF π^- CAPTURE BY HYDROGEN IN CHEMICAL COMPOUNDS. Krumshtein, Z. V.; Petrukhin, V. I.; Ponomarev, L. I.; Prokoshkin, Yu. D. (Joint Inst. of Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 55: 1640-4 (Nov. 1968). (In Russian).

The probability for π^--meson capture by hydrogen is measured in various chemical compounds (bases, salts, and pseudohydrides). The experimental results can be satisfactorily explained by the large mesomolecule model. In the case of compounds with q identical groups containing hydrogen, the probability for π^--meson capture by bound hydrogen is decreased q times due to quantum-mechanical resonance. The probability for π^--meson capture in pseudohydrides is much smaller than in normal hydrides which speaks of the complex structure of pseudohydrides. (auth)

5222 ENERGY LOSS SPECTRA FOR KILOVOLT-ENERGY ELECTRONS INTERACTING WITH THE SHELLS OF NOBLE GAS ATOMS. Afrosimov, V. V.; Gordeev, Yu. S.; Lavrov, V. M.; Shchemelinin, S. G. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 55: 1569-77(Nov. 1968). (In Russian).

The interaction of 3- and 4-keV electrons with various electron shells of the Ne, Ar, Kr, and Xe atoms is studied. An electron beam was passed through a chamber filled with the gas and the energies of electrons scattered into a fixed angle were recorded by means of an electrostatic analyzer. The inelastic energy loss spectra of electrons for several fixed scattering angles and also the angular dependences of the scattering cross sections for several values of the inelastic losses are obtained. The investigations were performed for inelastic energy losses lying between 0 and 450 eV and for scattering angles between 1° and 12°. The inelastic energy loss spectra of electrons interacting with the outer shells of the various atoms are similar and possess a complex structure characterized by the presence of two maxima. One of the maxima is located at energies only slightly exceeding the ionization threshold. The position of the second maximum depends on the scattering angle and approximately satisfies the conditions for which the momentum lost by a fast electron is completely transferred to the electron expelled from the atom. The inelastic energy loss spectra for electrons interacting with the inner shells have different shapes for the various atoms. The loss spectra for the N shell of the xenon atom is compared with the theoretical calculations carried out in the one-particle approximation with allowance for many-particle effects. The comparison shows that in this case many-particle effects play an important role. (auth)

5223 EMISSION OF RADIATION BY A FAST CHARGED PARTICLE IN AN INHOMOGENEOUS PERIODIC MEDIUM. Bolotovskii, B. M.; Chukhovskii, F. N. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 55: 2011-15(Nov. 1968). (In Russian).

The radiation from a charged particle in a medium with a periodically varying density emitted in a plane perpendicular to the direction of the particle velocity is considered. It is shown that even "weak" periodicity leads to a spatial redistribution of the radiation field near the resonance frequencies. Formulas are derived for the electromagnetic field and spectral density of first-order resonance radiation. The limits of applicability of the formulas are considered. (auth)

5224 ELECTRIC DIPOLE MOMENT OF THE CESIUM ATOM, A NEW UPPER LIMIT TO THE ELECTRIC DIPOLE MOMENT OF THE ELECTRON. Weisskopf, M. C.; Carrico, J. P.; Gould, H.; Lipworth, E.; Stein, T. S. (Brandeis Univ., Waltham, Mass.). Phys. Rev. Lett., 21: 1645-8(Dec. 9, 1968).

An atomic-beam magnetic-resonance apparatus has been used in a test of parity and time-reversal invariance in atomic systems. An upper limit to the permanent electric dipole moment of the cesium atom, $|d_{Cs}| < 3.7 \times 10^{-22}e$ cm, has been set. This result leads to an upper limit to the electric dipole moment of the electron, $|d_e| < 3 \times 10^{-24}e$ cm. (auth)

5225 ELECTRON-IMPACT EXCITATION OF THE 6^2P STATES IN CESIUM. Hertel, Ingolf V.; Ross, Kevin J. (Southampton Univ., Eng.). Phys. Rev. Lett., 21: 1511-12(Nov. 25, 1968).

The ratio of the differential cross sections at zero-angle scattering for the excitation of the $6^2P_{\frac{1}{2}}$ and $6^2P_{\frac{3}{2}}$ states in Cs has been measured for incident-electron energies between 3 and 68 eV. At 68-eV incident-electron energy the ratio is found to be 1.85, as predicted from degeneracy, but decreases significantly below 20-eV incident-electron energy. (auth)

5226 DEPENDENCE OF MAGNETIC ENHANCEMENT OF HELIUM NEUTRAL LINES UPON THE SPECTRAL SERIES. Takeyama, H.; Takezaki, Y. (Hiroshima Univ.). J. Quant. Spectrosc. Radiative Transfer, 8: 1863-5(Dec. 1968).

Intensities of nineteen He I lines emitted from a discharge tube capillary were measured as a function of a longitudinal magnetic field (up to 6 kG) by photoelectric photometry. The dc discharge current was 10.0 mA, and the helium pressure 3.0 torr. The results show that the only two spectral series, i.e., 2^1P-n^1D and 2^1S-n^1P, are enhanced by the field, with maxima at about 2 kG, and that the other four series in the visible region, i.e., 2^1P-n^1S, 2^3S-n^3P, 2^3P-n^3S and 2^3P-n^3D, are monotonically decreased with field strength. (auth) (UK)

5227 HIGH-ENERGY LIMIT IN REARRANGEMENT COLLISIONS. Dettmann, K.; Leibfried, G. (Technische Hochschule, Aachen). Z. Phys., 218: 1-24(1969).

The cross section for particle exchange from ground state to ground state in a three-particle collision is investigated. An asymptotic expansion for high incident energies can be given if the Fourier transforms of the interaction potentials allow an expansion in powers of 1/k for large k, which includes Coulomb interaction. It is shown that in general the first and second Born approximations provide the asymptotically leading terms. For special mass ratios, scattering into special (critical) angles becomes predominant. These angles, which are independent of energy, can also be determined employing classical arguments. Near the critical angles, single terms of either the first or second Born approximation become dominant. If the exchanged mass is small, the interaction between the two heavy masses cancels near forward direction, implying the validity of the impact parameter theory. The results are discussed for Coulomb interaction as the simplest example (electron exchange). Here, the contributions by critical scattering are small unless the energies become exceedingly large. (auth)

5228 QUENCHING OF ORTHOPOSITRONIUM BY HELIUM. Barker, M. I. (Univ. of Durham, Eng.); Bransden, B. H. J. Phys., B (London), 1: 1109-14(Nov. 1968).

Measurements of the quenching rate of orthopositronium in helium determine the parameter $^1Z_{eff}$, the effective number of electrons per atom in a singlet state relative to the positron. This number may be calculated from the wave function for the orthopositronium–helium atom system. This wave function is computed in the static-exchange approximation and in an approximation that allows for the long-range van der Waal's forces acting between the neutral atoms. The calculated values of $^1Z_{eff}$ at thermal energies are 0.037 and 0.048, respectively. These values are considerably smaller than the most recently measured values of 0.1 to 0.25, and the possible reasons for the discrepancy are discussed. (auth) (UK)

5229 THE RELATION BETWEEN IONIZATION YIELDS, CROSS SECTIONS, AND LOSS FUNCTIONS. Peterson, L. R.; Green, A. E. S. (Univ. of Florida, Gainesville). J. Phys., B (London), 1: 1131-40(Nov. 1968).

A self-consistent description of the three energy-dependent quantities involved in electron–atom and electron–molecule scattering, ionization cross sections, loss functions, and ionization yields, is examined. The parameters in analytical formulae that accurately describe the differential energy-loss cross sections and the loss function for any gas—in particular for He, H_2, N_2 and O_2—are obtained. The ionization yield in the keV region, or equivalently the energy per ion pair, is found to be useful in fixing the loss function at energies in the 100-eV region. If careful measurements of ionization yield down to the 100-eV region were available, and if the ionization cross sections at keV energies were more accurate, one could in principle determine a consistent L(E) to still lower energies. (auth) (UK)

5230 THE EFFECT OF APPARATUS GEOMETRY ON H^+–H, H^+–D, AND D^+–D CHARGE-EXCHANGE CROSS SECTIONS. Crothers, D. S. F.; Kennedy, M.; Smith, Francis J. (Queen's Univ., Belfast). J. Phys., B (London), 1: 1141-4(Nov. 1968).

The cross section Q_x for charge exchange between an incident ion and a target atom is usually measured by counting the number of ions scattered outside a cone about the incident direction. Only if the ion and atom have equal mass, and if the same-vertical angle $\frac{1}{2}\phi$ of the laboratory cone be 45°, is the number of ions counted known to equal the total number of exchange ions. Otherwise, the measured cross section $Q(\phi)$ does not equal Q_x. It is nevertheless shown that, for H^+–H, H^+–D, and D^+–D, $Q(\phi)$ and Q_x differ negligibly except for small ϕ at energies below 100 eV. (auth) (UK)

5231 FRAGMENTATION OF MOLECULAR GASES BY 5 TO 45-keV PROTONS. Browning, R.; Gilbody, H. B. (Queen's Univ., Belfast). J. Phys., B (London), 1: 1149-56(Nov. 1968).

Collisions involving ionization and fragmentation by 5- to 45-keV protons during passage through thin targets of H_2, N_2, O_2, CO, and CH_4 were investigated by the mass-spectroscopic analysis of the secondary ionic products of single collisions. Particular care was taken to ensure that all these ions were collected and recorded with high efficiency, in spite of the wide spread in both their energies of formation and initial directions. Measured fragmentation cross sections were as much as five times larger than previously published values. It is shown that, although the energy variation of cross sections for the formation of undissociated molecular ions may be in general accord with the predictions of the simple adiabatic maximum rule, the application of this rule to dissociative processes involving the production of singly or doubly ionized fragments may give entirely misleading results. The measurements show that in all the cases investigated a significant fraction of the total secondary ion yield arises through collisions involving fragmentation. (auth) (UK)

5232 DIFFERENTIAL CROSS SECTIONS FOR IONIZATION OF THE HYDROGEN ATOM BY FAST CHARGED PARTICLES IN THE BINARY-ENCOUNTER THEORY AND BETHE THEORY. Vriens, L.; Bonsen, T. F. M. (Univ. of Utrecht). J. Phys., B (London), 1: 1123-30(Nov. 1968).

Differential cross sections for ionization of the hydrogen atom from the $n = 1$ and 2 states by fast charged particles are calculated in the binary-encounter and Bethe (first Born) theory. Comparison shows good agreement between the two theories for large momentum and energy transfer. It is shown that use of an unrealistic velocity distribution of the target electron in the binary-encounter theory can lead to very poor results. If, in the Bethe theory, the Coulomb final-state wave functions are approximated by plane final-state wave functions, the same correct cross sections are obtained at and near the Bethe ridge for large momentum and energy transfer as in the Bethe and binary-encounter theories, but very poor results are obtained for small momentum and energy transfer. In the Bethe theory the numerically calculated differential cross sections per unit energy transfer ϵ (in Rydberg units) are found to be proportional to $\epsilon^{-2} + (4/3n^2)\epsilon^{-3}$ for large ϵ, in agreement with the corresponding binary-encounter cross-section formula. For ionization from the $n = 2$ states (Bethe theory) the proportionality factors in the asymptotic total cross-section formula were calculated, and also the continuum contributions to the optical oscillator strength and the polarizability. (auth) (UK)

5233 IONIZATION OF NEUTRAL ATOMS WITH OUTER 2p AND 3p ELECTRONS BY ELECTRON AND PROTON IMPACT. Peach, G. (University Coll., London). J. Phys., B (London), 1: 1088-1108(Nov. 1968).

The Born approximation is used to calculate cross sections for the ionization by electron and proton impact of all neutral atomic systems in the sequences boron to neon and aluminium to argon. Possible exchange between the incident and atomic electrons is approximately taken into account using the Ochkur approximation to the exchange amplitude. In the cases where experimental data exist for comparison there is agreement at high energies to within about a factor of 2, a discrepancy that may be partly explained by the simple approximation made to the true wave function of the ejected electron. (auth) (UK)

5234 ELASTIC SCATTERING OF ZERO-ENERGY ELECTRONS BY HELIUM ATOMS. Houston, S. K. (Univ. of Sheffield, Eng.). J. Phys., B (London), 1: 1077-82(Nov. 1968).

Scattering lengths and their reciprocals for elastic collisions between zero-energy electrons and helium atoms were calculated using Kohn's variational method. The trial function used makes explicit allowance for correlation between the incident electron and the atomic electrons, and is properly antisymmetrized to allow for electron exchange. In addition the trial wave function depends upon three exponential parameters, as well as a number of linear parameters. The "best" values obtained are 1.10 a_0 for the scattering length, and $(1.11\ a_0)^{-1}$ for the reciprocal of the scattering length. The value for the scattering length is slightly lower than the 1965 experimentally determined value 1.15 a_0 of Golden and Bandel but is very close to the value 1.097 a_0 calculated by LaBahn and Callaway in 1966. (auth) (UK)

5235 ROTATIONAL EFFECTS IN ELECTRON–MOLECULE RESONANCES. Read, F. H. (Univ. of Manchester, Eng.). J. Phys., B (London), 1: 1056-60(Nov. 1968).

The angular distribution coefficients for the resonant scattering of electrons by molecules are attenuated if the molecule has time to rotate during the lifetime of the resonance. The amount of the attenuation is calculated for different types of molecules, and the results are presented in graphical form. (auth) (UK)

5236 INNER-ELECTRON REARRANGEMENT IN THE HARTREE–FOCK SCHEME. Gianturco, F. A. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., B (London), 1: 1011-15(Nov. 1968).

Atomic self-consistent-field calculations are performed by numerical solution of the Hartree–Fock equations on each of the atoms in the third row of the periodic system, both with all the valence electrons present and with all the valence electrons absent. Ionization energies resulting when the inner shells are not allowed to relax, as well as the contributions to the ionization energies from the relaxation of the inner shells, are evaluated along that series for the first time, and are separately examined; contributions shown by the 1s, 2s, and 2p orbitals on stripping off of the valence electrons are not all of the same sign. The same is true of the changes in the mean radii of these orbitals. These results are explained in terms of exchange and Coulomb interactions between inner and valence (outer) shells, and as a consequence of the variations in the nuclear screening. The accuracy of Koopmans' theorem (1933) for monovalent species is tested by comparison with the Hartree–Fock contribution to the ionization potential of the valence electron. Hartree–Fock and experimental ionization potentials are also compared along the above-mentioned series of third-row elements. (auth) (UK)

5237 ASYMPTOTIC EXPRESSION FOR THE CROSS SECTION FOR THE EXCITATION OF H ATOMS BY FAST PROTONS. Khandelwal, G. S. (Univ. of North Carolina, Chapel Hill.). J. Phys., B (London), 1: 1220-1(Nov. 1968).

An asymptotic expression for the cross section for the excitation of H atoms from 1s to any state n by fast protons is found to give values in good agreement with those given by Cheshire and Kyle (1966). The validity of this expression is discussed. (auth) (UK)

5238 EXCITATION OF H ATOMS BY FAST PROTONS. Khandelwal, G. S. (Univ. of North Carolina, Chapel Hill). J. Phys., B (London), 1: 1218-19(Nov. 1968).

Cross-section formulae for the excitation of H atoms in 2s and 2p states to any state n by fast protons are obtained. (auth) (UK)

5239 ACCURATE FIRST BORN APPROXIMATION CROSS SECTIONS FOR THE EXCITATION OF HELIUM BY FAST PRO-

TONS. Bell, K. L.; Kennedy, D. J.; Kingston, A. E. (Queen's Univ., Belfast). J. Phys., B (London), 1: 1037-47(Nov. 1968).

Accurate first Born approximation cross sections for the proton excitation of the ground state of helium to the $n\,^1S(n = 2 \text{ to } 7)$, $n\,^1P(n = 2 \text{ to } 4)$, and $3\,^1D$ states were obtained using many-parameter correlated wave functions for both the initial and final states. Calculations for excitation to the $n\,^1S(n = 2 \text{ to } 6)$, $n\,^1P(n = 2 \text{ to } 6)$, and $n\,^1D(n = 3 \text{ to } 6)$ states were also performed using a six-parameter ground-state wave function and unrestricted Hartree–Fock excited-state wave functions, and in these calculations both the length and velocity formulations of the Born approximation integrals were evaluated. A comparison of these cross sections is made with recent theoretical and experimental results. In general, the agreement between theory and experiment is not good. (auth) (UK)

5240 BORN CROSS SECTIONS FOR THE ELECTRON AND PROTON EXCITATION OF HELIUM CALCULATED USING UNRESTRICTED HARTREE–FOCK WAVE FUNCTIONS. Bell, K. L.; Kennedy, D. J.; Kingston, A. E. (Queen's Univ., Belfast). J. Phys., B (London), 1: 1028-36(Nov. 1968).

Unrestricted Hartree–Fock wave functions are obtained for the $n\,^1S(n = 1 \text{ to } 6)$, $n\,^1P(n = 2 \text{ to } 6)$, and $n\,^1D(n = 3 \text{ to } 6)$ states of atomic helium, and are used to calculate the first Born approximation cross sections for electron and proton excitation of the ground state of helium to these states. Calculations are carried out using both the length and velocity formulations of the Born approximation integrals and comparison with accurate values shows that these wave functions yield entirely satisfactory results for excitation of $n\,^1S$ and $n\,^1P$ states, but are unsatisfactory for excitation of $n\,^1D$ states. (auth) (UK)

5241 EMISSION OF PARTICLE IN MOTION AROUND A PLANE PERPENDICULAR TO THE INTERFACE OF TWO MEDIA. Angeleiko, V. V. (Kharkov State Univ.). Zh. Tekh. Fiz., 38: 1500-4(Sept. 1968). (In Russian).

Emission from a charged particle moving along the circumference of a plane perpendicular to the boundary of two media was studied. The particle motion along the circumference was accompanied by magnetic bremsstrahlung that was reflected and refracted by the surface interface. A transitional emission was observed during particle movement from one medium to another. Expressions were obtained for time-averaged angular distributions of the particle in both media, and for electromagnetic emission of a linear harmonic oscillator with an axis perpendicular to the interface of the media. (R.V.J.)

5242 POSITRON ANNIHILATION IN METAL–AMMONIA SOLUTIONS. Varlashkin, Paul G. (Louisiana State Univ., Baton Rouge). J. Chem. Phys., 49: 3088-91(Oct. 1, 1968).

The momentum distribution of photons from positrons annihilating in liquid sodium–ammonia solutions of several concentrations was found to be concentration-independent and the same as that of previously measured $LiNH_3$ liquid solutions. Single-concentration angular correlation measurements made on KNH_3 and $RbNH_3$ liquid solutions showed the same momentum distribution as the $LiNH_3$ and $NaNH_3$ liquid solutions. In the case of $LiNH_3$ and $CaNH_3$ solutions, which retain their metallic characteristics even when frozen, freezing leaves the general shape of the momentum distribution essentially unaltered. When a dilute $NaNH_3$ solution was frozen, the angular correlation of photons from positrons annihilating in the solid was found to be identical with that obtained from annihilations in pure solid NH_3. This is indicative of precipitation of the sodium at the time of freezing. The angular correlations of photons from positrons annihilating in saturated liquid $LiNH_3$, solid $LiNH_3$, and solid $CaNH_3$ show the same distribution at high momenta together with a concentration-dependent narrow component. As the solvated electron concentration is increased, the narrow component broadens slightly and the percentage narrow component decreases. Interpretation of the data suggests a large percentage of positronium formation. (auth)

5243 THEORETICAL EVALUATION OF ISOTROPIC CATHODE PULVERIZATION. Joyes, Pierre (CNRS, Orsay, France). J. Phys. (Paris), 29: 774-90(Aug.-Sept. 1968). (In French).

The first part of a theoretical study is presented on the emission of secondary ions upon impact of rare gas ions (energy of some keV) on metal targets. A model was developed which describes the ejection of randomly displaced particles during the cascades following the bombardment. This emission, which has an isotropic feature (''erratic emission''), is to be differentiated from the focusing collision emission; this emission is responsible for the ejection of atoms outside the closed packed directions of the lattice. Afterwards the model was checked by comparison with experimental results. Then a formation mechanism was proposed for the secondary ions from the internal electronic excitation created during violent impacts on some atoms of the cascade in the metal; by introducing the average lifetime of such an excitation, it is shown that the proposed model of the erratic emission can be easily adapted to a study of secondary ion emission. (auth)

5244 CHARGE-TRANSFER CROSS SECTIONS FOR N_2^+ IONS INCIDENT ON H_2 AND D_2 BETWEEN 20 AND 1000 eV. Haugsjaa, Paul O. (Univ. of Denver); Amme, Robert C.; Utterback, Nyle G. J. Chem. Phys., 49: 4641-3(Nov. 15, 1968).

Absolute cross sections for slow-ion production have been measured for beams of N_2^+ incident on H_2 and D_2 targets. The beam energy was varied from 20 to 1000 eV. A sharp maximum in the cross section was observed for the case of D_2 at a beam energy of about 100 eV. A more gentle maximum, lying close to 200 eV, was found for the H_2 target gas. These results are very similar to those found for argon ions on H_2 and D_2. The observed cross sections were found to vary only slightly with ionizing electron energy, which was varied between 16 and 25 eV. As an instrumental check, the intensity of the resulting neutral N_2 beam was examined and found to be consistent with that formed by symmetric charge transfer. (auth)

5245 THEORY OF ATOM–DIATOM COLLISIONS. II. Kouri, Donald J. (Univ. of Houston, Tex.). J. Chem. Phys., 49: 4481-99(Nov. 15, 1968).

A previous study of atom–diatom collisions based on the Feshbach projection-operator formalism is utilized in further considering the effects of closed channels on the open-channel wave functions. The study is restricted to situations where the only even-j open channel is $j = 0$. The Q-projected Hamiltonian consists of a part QH_0Q, which is diagonal in the $Y_{jl}^M(\hat{r},\hat{r}')$ basis, and a part QVQ, which is not diagonal. Because of this, the closed-channel kernel $1/(E - QHQ)$ is not diagonal in this basis. A nondiagonal representation of $1/(E - QHQ)$ is obtained and the order of magnitude of the effects of the off-diagonal coupling on resonance positions, widths, and shifts is estimated. Criteria for determining the number of resonances that need to be included is examined. Additionally, the order of magnitude of the effect on resonance positions of off-diagonal coupling of near to far resonances is shown to be smaller than that between coupled near resonances. A brief study of the system $Xe-H_2$ is made to examine the magnitude of the effect on the resonance positions of changes in the interaction potential as compared to that due to off-diagonal coupling. The resonance cross sections, positions, level widths, and shifts depend on the asymmetry factor a and should be sensitive to the short-range portion of the interaction. The direct cross section will be essentially independent of the asymmetry a (for $j = 0 \rightarrow j = 0$ case). (auth)

5246 CHARGE TRANSFER AND DISSOCIATIVE CHARGE TRANSFER BETWEEN RARE-GAS IONS AND MOLECULAR NITROGEN. Champion, R. L.; Doverspike, L. D. (Univ. of Florida, Gainesville). J. Chem. Phys., 49: 4321-9(Nov. 15, 1968).

The reactions of He^+, Ne^+, and Ar^+ with N_2 giving charge transfer and dissociative charge transfer have been studied for low collision energies. Kinetic-energy distributions and angular distributions of N_2^+ and N^+ have been measured. In all cases the reactions proceed via a variety of endothermic or exothermic channels. Product ions are found to be scattered at large c.m. scattering angles, but do not appear to be isotropic in the c.m.s. For dissociative charge transfer, the data are consistent with a two-step process involving first an electron transfer by predissociation. It is emphasized that these low-energy charge-transfer reactions are not conceptionally different from ion–molecule (reactive) collisions. (auth)

5247 NUMERICAL ONE-CENTER CALCULATION OF THE $ns-\sigma$ RYDBERG SERIES OF H_2^+. Winter, N. W.; McKoy, Vincent (California Inst. of Tech., Pasadena). J. Chem. Phys., 49: 4728-30(Nov. 15, 1968).

First-order perturbation theory was used to calculate the energies and quantum defects for the lowest eight $s-\sigma$ state of H_2^+. The first-order wave function for the ground state included partial waves up to $2l = 16$ and the remaining states up to $2l = 12$. Results for each level are tabulated. The contribution of each partial wave to the second-order energy for each excited state is also tabulated. (A.G.W.)

5248 THREE-BODY ELECTRON CAPTURE BY NITROUS OXIDE. Warman, John M.; Fessenden, Richard W. (Mellon Inst., Pittsburgh). J. Chem. Phys., 49: 4718-19(Nov. 15, 1968).

The pressure dependence of thermal electron decay in nitrous oxide at 300°K was studied. The results are in accordance with a three-body attachment process. The three-body rate constant derived from the results is $5.6 \pm 0.2 \times 10^{-33}$ cm^6 sec^{-1}. (A.G.W.)

5249 DETERMINATION OF THE Li–Hg INTERMOLECULAR POTENTIAL FROM MOLECULAR-BEAM SCATTERING MEASURE-

MENTS. Olson, R. E. (Univ. of Wisconsin, Madison). J. Chem. Phys., 49: 4499-4503(Nov. 15, 1968).

The experimental differential-cross-section extrema data of Groblicki and Bernstein have been analyzed and yield a family of potential parameters. These results were combined with the inferences obtainable from the glory extrema in the total cross sections of Rothe and Veneklasen to deduce a potential compatible with both experiments. The resulting potential is found to have a well depth $\epsilon = 1.70 \times 10^{-13}$ erg ± 3% with a size parameter r_m = 3.02 Å ± 3%. The long-range coefficient is $C_6 = 4.4 \times 10^{-58}$ erg · cm^6 ± 60%. (auth)

5250 UPPER BOUNDS FOR VAN DER WAALS INTERACTIONS OF TWO AND THREE ATOMS. Tang, K. T. (Pacific Lutheran Univ., Tacoma). J. Chem. Phys., 49: 4727-8(Nov. 15, 1968).

A method for establishing the upper bounds of the two-body and three-body van der Waals coefficients for ground-state spherically symmetric atoms is reported. Results for mixtures of hydrogen and helium atoms are presented as an illustration. (A.G.W.)

5251 CLASSICAL MECHANICS OF ROTATIONAL–TRANSLATIONAL AND OTHER ENERGY TRANSFER. I. A HAMILTON–JACOBI (ACTION-ANGLE) TREATMENT. Cohen, Audrey O.; Marcus, R. A. (Univ. of Illinois, Urbana). J. Chem. Phys., 49: 4509-14(Nov. 15, 1968).

The classical-mechanical equations of motion describing collisional energy transfer are converted to a form involving constants of the elastic collision, using a Hamilton–Jacobi formalism. These constants frequently vary only slowly during an inelastic collision. An approximate version of the transformed equations, related to a variation of constants procedure, is next introduced. The collision of an atom with a rigid linear diatomic molecule is considered in some detail. Several desirable features of the approximation are that the change in rotational angular momentum is obtained directly, all initial orientations of particles and angular momenta occur outside the integrals, an approximate error estimate can be made, results can be calculated relatively quickly, and further insight is obtained into the energy-transfer process. Because of the close relationship of Hamilton–Jacobi and Schrödinger formalisms, a comparison of exact and approximate classical results is also expected to provide estimates of range of validity of some commonly used approximations in the quantum case. (auth)

5252 DISSOCIATION ENERGY AND VIBRATIONAL TERMS OF GROUND-STATE ($X^1\Sigma_g^+$) HYDROGEN. LeRoy, Robert J.; Bernstein, Richard B. (Univ. of Wisconsin, Madison). J. Chem. Phys., 49: 4312-21(Nov. 15, 1968).

In an attempt to elucidate the discrepancy between the theoretical and experimental dissociation energies of H_2, accurate binding energies and term differences have been computed for the 15 vibrational levels using the Kolos and Wolniewicz clamped-nuclei potential with its various corrections. The results suggest possible interpretations of the discrepancy. In one of these an extrapolation method is introduced, which combines experimental term differences with computed binding energies for the uppermost levels to yield the dissociation energy; this result is in accord with the experimental value of Herzberg and Monfils. The effect of uncertainties in the values of the natural constants is considered. Apparent inconsistencies between previously computed vibrational energies are explained. (auth)

5253 CONTRIBUTION TO THE THOMAS–FERMI THEORY. Tietz, T. (Univ. of Lodz, Poland). J. Chem. Phys., 49: 4391-3(Nov. 15, 1968).

A procedure is given for calculating one-electron eigenvalues and eigenfunctions for the Schrödinger equation with the Thomas–Fermi potential. It has been shown that the Schrödinger equation in this case gives relatively good results in comparison with the Hartree results. The obtained numerical eigenvalues of this paper are compared with the corresponding Hartree values. (auth)

5254 THE LAMB SHIFT IN SINGLY IONIZED HELIUM. Narasimham, Musti Appala. Boulder, Colo., Univ. of Colorado, 1968. 149p.

Thesis.

The energy difference (S) between the $2^2S_{1/2}$ and $2^2P_{1/2}$ states of singly ionized helium was measured accurately using a microwave power method. Helium atoms inside a spherical mirror Fabry–Perot resonator were bombarded continuously by 200-eV electrons to produce helium ions in the $2^2S_{1/2}$ metastable state. Transitions were induced in these metastable ions by the applied, modulated rf power of constant frequency to the short-lived $2^2P_{1/2}$ ionic state. The 40.8-eV photons emitted by the decay of the $2^2P_{1/2}$ ions to the ionic ground state were quantum converted to visible photons by a scintillator and then guided to a photomultiplier. The output of the photomultiplier was detected and amplified synchronously with the rf power. The experiment made use of the Zeeman effect of the fine structure and was done in an applied homogeneous magnetic field. The resonance line shape and hence the center were obtained by sweeping the magnetic field. Three different operating values for the helium pressure were used and the result extrapolated to a zero pressure value. A thorough search was made for all possible systematic errors in the experiment. The value for S thus obtained was 14045.4 ± 1.7 MHz. The quoted uncertainty consists of three standard deviations for the statistical error plus systematic errors. This result agrees with the previous experimental values for S (within three standard deviations only), but disagrees with the present theoretical value of 14038.17 ± 4.4 MHz. (Diss. Abstr.)

Cosmic Radiation

Refer also to abstracts 4805, 5137, 5143, 5527, and 5530.

5255 MEASUREMENT OF THE CHARGE SPECTRUM OF PRIMARY COSMIC RAYS DURING THE 1965 SOLAR MINIMUM. Hasler, H. G. (Univ., Kiel). Z. Geophys., 34: 469-82(Nov. (1968). (In German).

The development of a Cherenkov scintillation counter is described which has been used to measure the galactic cosmic-ray charge spectrum during the recent period of minimum solar activity. The balloon flight was carried out on Oct. 23, 1965 (Mt. Washington hourly counting rate: 2448) at 4.8 g/cm^2 and at a mean cut-off rigidity of 2,66 GV. Evaluation of 25% of the recorded data gives the following preliminary result (particles/m^2 sterad sec): protons (1520 ± 250); alphas (166 ± 12); light nuclei (4.9 ± 1.5); medium nuclei (12.7 ± 1.3); and heavy nuclei (3.9 ± 0.7). The analysis of the underground counts shows that the flux of the secondary photons above 20 MeV at balloon altitude is anisotropic, the upward moving component being 3.5 times larger than the downward moving component. (auth)

5256 FORBUSH DECREASE OF MARCH 1966 OBSERVED IN THE NEUTRON, SEA-LEVEL MESON, AND UNDERGROUND MESON COMPONENTS. Andreis-Sandrucci, L.; Cini-Castagnoli, G.; Dodero, M. A. (Univ., Turin). Ann. Geophys., 24: 889-92 (July-Sept. 1968).

The Forbush decrease of March 23, 1966 observed in the underground meson component recorded in the "Monte Cappuccini" Laboratory at a depth of 70 mwe is presented. By comparing the intensity variations with those observed in the neutron and sea-level meson components, it is concluded that the energy spectrum of the variation remains rather flat up to energies well above 100 GeV. Parker's blast-wave theory was applied to this event, leading to the conclusion that this Forbush decrease appears as the result of a weak, substained blast wave. (auth)

5257 EVOLUTIONARY EFFECTS OF COSMIC RADIATION. Simpson, G. G. (Harvard Univ., Cambridge, Mass. Univ. of Arizona, Tucson). Science, 162: 140-1(Oct. 4, 1968).

It seems that recent discussion and arguments both pro and con on the biological effects of supernova explosions have taken insufficient account of the actual features of the known fossil record that proponents of these hypotheses seek to explain. Five considerations which are thought to be pertinent are given and it is concluded that neither the supernova hypothesis nor the geomagnetic reversal hypothesis is in agreement with the biohistorical record. (W.D.M.)

5258 STRATOSPHERIC SUDDEN WARMINGS AND COSMIC RAYS IN THE ANTARCTIC. Inoue, Aoi; Kodama, Masahiro (Inst. of Physical and Chemical Research, Saitama, Japan). Nankyoku Shiryo, No. 30, 1-12(1967). (In Japanese).

Using the data from Mawson, Antarctica, seven sets of partial temperature coefficients of the cosmic-ray meson component, recommended by Dorman and other authors, were examined on the basis of regression calculation analysis. The phenomenon of stratospheric sudden warming, which frequently appears in polar regions, is convenient for studying the atmospheric effect of cosmic rays, because the altitude dependence of the atmospheric temperature is largely different from that of usual days. The temperature coefficients by Dorman, by Maeda, and by Wada fit better with the observational results of all seven sets. It shows that the upper atmospheric temperature, which is difficult to measure continuously, may be presumed from the cosmic-ray intensities on the ground, if the accuracies of the cosmic-ray data and of the lower atmospheric temperatures are more than 10^7 counts per hour and 0.1°C, respectively. This estimation will be referred to in the forthcoming extension of the cosmic-ray observations in Antarctica. (auth)

5259 INFRARED LINES AND THE TEMPERATURE AND IONIZATION OF THE INTERSTELLAR MEDIUM. Pottasch,

S. R. (Groningen State Univ., Netherlands). Bull. Astron. Inst. Neth., 19: 469-78(June 1968).

A discussion is given on the effect of the cosmic-ray flux on the ionization of the interstellar medium. The several-percent ionization which is predicted increases the expected intensity of the ir line radiation from the interstellar medium, so that probably a large number of these lines are observable. A list of lines and their expected intensity is given. The emission of small interstellar clouds or nebulas in ir lines is also discussed. In this case, the cosmic-ray flux plays no role. A list of lines and their expected intensity from a typical cloud is given. (IAA)

5260 BAROMETRIC COEFFICIENTS OF MULTIPLICITIES IN NEUTRON MONITORS. Hatton, C. J.; Griffiths, W. K. (Leeds Univ., Eng.). J. Geophys. Res., 73: 7503-9(Dec. 1, 1968).

Using a simple model for cosmic-ray interactions in the atmosphere and the response of neutron monitors to secondary nucleons, the barometric coefficients of various multiplicities were calculated. The variation of these coefficients with multiplicity, latitude, and altitude is found to be in general agreement with experimental results. (auth)

5261 PROPAGATION OF SOLAR PROTONS. Kahler, Stephen Wilson. Berkeley, Calif., Univ. of California, 1968. 141p.

Thesis.

Data from a scintillation-counter experiment on the OGO-III spacecraft are used to analyze twelve energetic ($3 < E < 32$ MeV) solar proton events from June 1966 to February 1967. The OGO-III spacecraft, the performance of the experiment and methods of data analysis are discussed. The proton events presented here have been divided into four groups, each of which has well defined properties. The diffusive event follows an impulsive injection of particles at the sun and decays exponentially in time. The onset phase may be smooth or irregular, but the spectrum grows progressively softer during the decay phase. The storm particle event is a low-energy event associated with a geomagnetic storm. During this event the spectrum first grows softer, then becomes harder. The halo structure is a stream of particles confined to the interplanetary lines of force which connect to the flare region at the sun. Recurrent proton events are due to the gradual release of particles from an active region in which a flare has occurred during a previous solar rotation. The two examples reported here showed narrow (≲10 hours) interplanetary spatial confinement. Representative fluxes and modified spectral behavior are presented for these events. These events are used as a basis for describing a model of a typical solar proton event. The model of coronal diffusion of Reid and Axford is used. (Disser. Abstr.)

5262 VERY HEAVY NUCLEI IN THE PRIMARY COSMIC RADIATION. II. INTERPRETATION OF THE ENERGY SPECTRA. Waddington, C. J.; Freier, P. S. (Univ. of Minnesota, Minneapolis). Phys. Rev., 175: 1649-58(Nov. 25, 1968).

An attempt was made to understand the form of the observed energy spectrum of the highly charged ($20 \leq Z \leq 30$) nuclei in the primary cosmic radiation. It is shown that the behavior of this spectrum relative to that of the helium nuclei also present in the cosmic radiation can be explained by assuming that the highly charged nuclei have two components. The first of these components is dominant at high energies and has a spectrum at the source that can be represented as a simple power law with a slope somewhat flatter than that of the source spectrum of the helium nuclei. The nuclei in this component may be regarded as having traversed several g/cm^2 of matter between the times of acceleration and of detection. The second component is of importance only at relatively low energies (a few hundred MeV/nucleon), has a spectrum that falls steeply with increasing energy, and cannot simply be represented as a power law. The possible consequences of such a model are briefly considered. (auth)

5263 VERY HEAVY NUCLEI IN THE PRIMARY COSMIC RADIATION. I. OBSERVATIONS ON THE ENERGY SPECTRUM. Freier, P. S.; Waddington, C. J. (Univ. of Minnesota, Minneapolis). Phys. Rev., 175: 1641-8(Nov. 25, 1968).

The intensities and energy spectrum of the medium- and very heavy, MH and VH, nuclei, $16 \leq Z \leq 30$, present in the primary cosmic radiation were studied using three stacks of nuclear emulsions exposed on high-altitude balloons flown over Fort Churchill (Canada), Texas, and India. Integral intensities of $Z \geq 20$ nuclei above energies of 0.225, 1.58, and 7.1 BeV per nucleon were, respectively, 1.50 ± 0.06, 0.403 ± 0.023, and 0.090 ± 0.006 (VH nuclei)/m^{2}sr sec. The energy spectrum of these nuclei was measured in detail between 225 MeV per nucleon and 1 BeV per nucleon, and was found to exhibit a maximum in the 300- to 400-MeV per nucleon range, where the differential intensity was of the order of 1.7×10^{-3} nuclei/m^2 sr sec (MeV per nucleon). Integral intensities of $16 \leq Z \leq 19$ nuclei above energies of 1.58 and 7.1 BeV per nucleon were, respectively, 0.086 ± 0.010 and 0.020 ± 0.003 nuclei/m^2 sr sec; differential intensities were also measured at lower energies. (auth)

5264 COSMIC-RAY PROPAGATION. Fichtel, C. E.; Reames, D. V. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 175: 1564-76(Nov. 25, 1968).

The general problem of the propagation of cosmic rays from their source until they are observed in the vicinity of the earth is reviewed. The effect of matter on the cosmic-ray composition is considered in detail, and the effect of diffusion is treated in the depth necessary to study some models of the cosmic radiation not previously considered in this manner. The results of these calculations show that there are some aspects of the experimental observations, such as the ratio of light to medium nuclei as a function of energy, which are not consistent with any equilibrium model of the cosmic radiation which does not include a rigidity dependence in the mean free path. This conclusion is independent of the source spectrum assumed and is valid for a large class of source distributions. A series of possible explanations for the discrepancy between the observed experimental data and the theoretical predictions of the equilibrium picture are considered, and shown to be unlikely. Faced with this dilemma, attention is turned to a simple nonequilibrium model, consisting of one fairly close single source superimposed on a general background. This picture was chosen because it seemed the simplest first step from equilibrium. The calculations show that this picture leads to considerably better agreement with the experimental data, especially on the ratio of light to medium nuclei as a function of energy/nucleon. At least one irreconcilable experimental datum remains, namely, the one measurement of the fluorine-to-oxygen ratio. (auth)

Direct Energy Conversion

5265 (JPRS-46941) IONOSPHERIC MHD GENERATOR. Poletavkin, P. Translated from Nauka Zhizn, [34:] No. 9, 4-40(1968). 17p. CFSTI.

A new possible method for producing electric power, by using the ionosphere to form a gigantic MHD generator, is examined. In the ionosphere, solar radiation produces a plasma, whose expansion in the geomagnetic field induces an emf and an electric current passing around the earth in the west direction. The problem is to connect a load with the ionosphere, and it is suggested that the connection be made by means of plasma columns created by two nuclear reactors open to the sky. Some rough calculations are given for the maximum effective power of such an ionospheric MHD generator. A discussion of the ideas is included. (D.L.C.)

5266 (NP-17676) SEPARATE EVALUATIONS OF ELECTROGASDYNAMIC (EGD) POWER GENERATION. Office of Coal Research, Research and Development Report No. 35. (Dynatech Corp., Cambridge, Mass. IIT Research Inst., Chicago, Ill. Iowa State Univ. of Science and Technology, Ames). [1968]. 129p.

Research and developmental work carried out June 1967 to August 1968 on electrogasdynamic power generation is presented. Basics of an operating plant are described. Recommendations from the feasibility study are discussed. (M.O.W.)

5267 TWO-DIMENSIONAL ANALYSIS OF THE MHD GENERATOR WITH SERIES CONNECTED ELECTRODES. Celinski, Z. (Plasma Physics and Tech. Inst., Warsaw). Arch. Elektrotech. (Warsaw), 17: 47-68(1968). (In Polish).

Distribution of electrical parameters in an MHD generator with electrodes connected in series was determined by numerical analysis for a wide range of electrode dimensions and values of the Hall parameter. The method of determining the generator terminal values, based upon the results of the numerical calculations, was worked out. Deviations of the generator parameter terminal values in finite-length electrode generators were determined from those in the ideal case of infinitely segmented electrodes. The correction factors λ were calculated and presented in the form of curves as functions of geometric dimensions (parameter s/h), electrode size (parameter c/s), Hall parameter (β), and electric connections (parameter α). Constant gas-dynamic parameters and constant (for maximum electrical power), $(c/s)_{opt}$ was determined. It is a function of parameters s/h, β and α. Optimum electrode connection (for maximum electric power), α_{opt} was also determined. This is a function of parameters s/h, β and c/s. The magnitude of α_{opt} is higher than determined from one-dimensional analysis ($\alpha_{opt} = 1/\beta$) and is $\alpha_{opt} \approx (1/\beta) + (s/h)$ for $c/s \approx 0.5$. Comparison of various systems for making the electrical connections between the electrodes indicated the most advantageous system, namely that of connecting the electrodes in series with $\alpha = \alpha_{opt}$ and $c/s = c/s_{opt}$. This gave the maximum electrical power, the minimum possible number of separate load circuits, and the most advantageous parameters of elec-

trical power, high voltage, and low current. The influence of finite-length electrodes on electrical parameters in an MHD generator is generally great. The choice of electrode width, especially for large β is not critical. The paper permits the simple determination, by introducing a correction factor λ of an estimate for the deviation of all electric parameters from their theoretical values obtained in the one-dimensional analysis. (tr-auth) (ATD)

5268 IMPROVEMENTS IN OR RELATING TO THERMOELECTRIC GENERATORS. Phillips, Leopold Samuel (to G. V. Planer Ltd.). British Patent 1,133,611. Nov. 13, 1968. Filed Oct. 8, 1964.

A method of construction is described for a thermoelectric generator having a thermocouple module comprising an array of thermocouple members of suitably different thermoelectric materials. The method includes the step of depositing a thin layer of electrical insulating material upon the contact straps which interconnect the thermocouple members at the hot junction end of the already assembled module. The next step is depositing upon the insulating material a further layer of a metal suitable for the subsequent securing thereto of a heat conductive metal element by soldering or brazing. (M.H.R.)

5269 THEORY OF NEAR-ELECTRODE LAYER IN A LOW TEMPERATURE PLASMA. Baksht, F. G.; Moizhes, B. Ya. Zh. Tekh. Fiz., 38: 724-36(Apr. 1968). (In Russian).

The factors determining the distribution of the concentration, potential, and ionization in the vicinity of the electrode of a thermionic converter are considered. To facilitate the analysis, a model is discussed in which it is possible to break up the electrode layer into two regions, a collisionless space-charge region, and a collision-governed quasineutral diffusion region. The solution obtained for each of the regions is made continuous on the boundary between them. The conditions for joining these solutions make it possible to estimate the drift velocity of the ions on the boundary between the regions. The average boundary conditions that determine the particle flux and the energy flux in a plasma are obtained for electrodes in which the emission takes place from individual spots whose dimensions are large compared with the Debye–Hückel radius. The ion current to the cathode is determined, with allowance for the ionization and recombination in the electrode region that separates the electrode from the plasma in thermodynamic equilibrium. (ATD)

5270 ANALYSIS OF THE OPERATION OF A MAGNETOHYDRODYNAMIC GENERATOR WITH THE AID OF VECTOR DIAGRAMS. Celinski, Z. (Inst. for Nuclear Research, Warsaw). Arch. Elektrotech. (Warsaw), 16: 1021-37(1967). (In Polish).

A method is described for analyzing the electrical quantities of an MHD dc generator with the aid of vector diagrams. The method is based on the relationships between the vectors of electrical values as specified by a generalized Ohm's law, and on the relationships between the vectors of electric fields in a stationary and moving system of coordinates. On the basis of the generalized Ohm's law, the geometrical end points of the vectors are determined in a complex-variable plane with variable Hall-parameter values, a variable load coefficient, and a variable system of electrode connections. The method makes it possible to obtain a representative formulation of the relations between the electrical quantities of the generator, thus leading to some simple analytical expressions. It is possible to construct diagrams for a direct reading of the electrical quantities, without the necessity of supplementary calculations. (IAA)

Fluid Physics

Refer also to abstract 5404.

5271 VARIATIONS IN GAS RATE IN IONIZING SHOCK WAVES. THE PROBLEM OF CONDUCTIVE PUMPING. Barmin, A. A.; Kulikovskii, A. G. Prikl. Mat. Mekh., 32: 495-9 (1968). (In Russian).

Data were obtained on the rate variations in ionizing shock waves, arbitrarily oriented in relation to the magnetic field and dissipating along the gas whose magnetic viscosity is many times higher than other dissipative coefficients. A case in which the gas propagates in a plane distributed along the normal to the ionizing wave and the magnetic field in front of it was investigated. The results obtained were used for resolving self-similar problems on movement in conductive pumping. (R.V.J.)

5272 HALL EFFECTS ON THERMAL INSTABILITY IN A ROTATING LAYER OF A CONDUCTING FLUID. Rai, Lajpat (Indian Inst. of Tech., Kharagpur, India). Can. J. Phys., 46: 2533-7(Nov. 15, 1968).

The effects of Hall currents on the convective instability of a rotating layer of a conducting fluid in the presence of a vertical magnetic field are discussed. It is found that the Hall currents are always destabilizing in the absence of rotation but tend to stabilize the flow as soon as the rotation exceeds certain limits. An analytical condition for nonexistence of overstability is also derived. (auth)

5273 NONANALYTICITY AT THE SURFACE OF A BODY IN AN OHD OR MHD STREAM. Boger, R. C.; Ludford, G. S. S. (Cornell Univ., Ithaca, N. Y.). Quart. Appl. Math., 26: 284-7 (July 1968).

Army-supported research derivation is made of the form of the singularities arising at the surface of an immersed body as the result of extreme stretching of vortex lines in OHD and MHD inviscid flow past a stagnation point. To derive the form, it is sufficient to treat the front stagnation point of a body, which is responsible for the nonanalyticity. Results are equally applicable to compressible and incompressible fluids. (IAA)

5274 GENERATION OF ALFVEN WAVES FROM TURBULENCE. Kato, Shoji (Tokyo Univ.). Astron. Soc. Jap., Publ., 20: 59-72(1968).

A derivation is presented of the inhomogeneous wave equation describing the generation of Alfvén waves from a hydromagnetic turbulence. The rate of generation is evaluated by using the Green function for a one-dimensional wave equation. The medium is assumed to be incompressible and uniform, and subject to a constant external magnetic field. It is shown that, in general, the ratio of the rate of radiation loss to that of the nonradiative dissipation (cascade) of turbulent energy is proportional to the Alfvén number of turbulent velocity for small Alfvén numbers. When the Alfvén number is larger than unity, the ratio becomes nearly a constant. Numerical coefficients of proportionality are obtained for a model of isotropic turbulence. (IAA)

5275 STAGNATION FLOW AND HEAT TRANSFER IN A ZONAL MAGNETIC FIELD. D'Sa, E. R. (Makerere Univ. Coll., Kampala, Uganda). J. Eng. Math., 2: 153-61(Apr. 1968).

An analysis is made of stagnation flow on a blunt-nosed body for small values of the diffusivity ratio ϵ and the magnetic force coefficient β, the magnetic field being of internal origin. Uniformly valid expansions are derived for the velocity and magnetic fields in the fluid. It is found that as $\beta \to 1$, the viscous layer is brought to rest and the current in the layer is uniform and normal to the wall. The heat transfer is next calculated at a uniformly heated wall on the assumption of small temperature variations. It is deduced that when $\beta \log(\epsilon^{-1})$ approaches a certain value depending on the wall temperature, etc., the thermal boundary layer separates at the stagnation point and, if dissipation is neglected, along the whole wall. (auth) (IAA)

5276 THE FLOW OF A CONDUCTING FLUID IN A CHANNEL IN THE FORM OF A RIGHT ANGLE TRIANGLE IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD. Hirsch, Ch. (Univ., Brussels). Bull. Cl. Sci., Acad. Roy. Belg., 54: 452-67 (1968). (In French).

An exact solution is presented for the magnetohydrodynamic differential equations for a laminar steady-state flow of a conducting, viscous, incompressible conducting fluid in a cylindrical channel of right triangle cross section (right triangle with 30° angle) with nonconducting walls in the presence of a transverse magnetic field. The various situations for which the direction of the applied magnetic field is parallel or perpendicular to any of the walls were considered. The resolution method is based on a series development of eigenfunctions of the Helmholtz equation; the eigenfunctions are nullified on the walls of the right triangle and constitute a complete ensemble of orthonormal functions. (tr-auth)

5277 DECAY OF PLANE MAGNETOHYDRODYNAMIC AND GAS DYNAMIC SHOCKS IN AN IDEAL GAS. Karpp, Robert Raymond. Philadelphia, Drexel Inst. of Tech., 1968. 71p. Thesis.

The problem of a plane shock decayed by an overtaking rarefaction wave has been solved by a new approximate, analytical method. This method is not limited to weak shocks, and the accuracy is quite good for the early stages of motion but decreases for the later stages. Solutions have been obtained for shocks in an ideal gas and for shocks in a perfectly conducting ideal gas with an applied magnetic field. These solutions have been compared with an existing approximate method due to Friedrichs. The Friedrichs method neglects the entropy change across the shock; therefore, it is limited to weak shocks. For weak shocks, both solutions agree in the early stages; however, a significant difference arises for large values of time. Friedrich's method indicates that the width of the shock wave increases monotonically with time, but the present method predicts that the width of the

shock wave reduces to zero in a finite time. Results from a numerical solution based on the method of characteristics also indicate that the width of the shock wave decreases to zero. Therefore, when studying the behavior at large values of time, the entropy change across the shock cannot be neglected, even for weak shocks. (Disser. Abstr.)

5278 MAGNETOHYDRODYNAMIC WAVES IN SECOND-ORDER FLUIDS. Chawla, Sahib Singh (Inst. of Tech., Kharagpur, India). Int. J. Eng. Sci., 6: 75-87(May 1968).

A class of MHD waves has been investigated for second-order fluids, whose constitutive equations have been introduced by Coleman and Noll. The second-order coefficient plays an important role in the formation and propagation of waves. Waves of finite amplitude have also been discussed. In this case, the second-order coefficient modifies considerably what is known as streak effect. It is found that the introduction of elastic effects in fluids greatly influences the efficiency of the generation of Alfvén waves at a solid boundary. (auth) (IAA)

5279 EFFECT OF A MAGNETIC FIELD ON THE GROWTH OF TAYLOR INSTABILITY IN COMPRESSIBLE CONDUCTING FLUIDS. Nikolaev, Yu. M. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 5, 80-7(1967). (In Russian).

The effect of the magnetic field on the growth of Taylor instability is analyzed at the interface between two ideal, conducting, compressible fluids. The governing hydromagnetic equations are linearized, assuming exponential disturbances along the coordinate x, such that $\partial/\partial x \sim k$ and $\partial/\partial y = 0$. The characteristic equation is then developed. The frequencies characterizing the short- and long-wave disturbances indicate that the presence of a magnetic field has a stabilizing effect on the growth of Taylor instabilities. (TSS) (ATD)

5280 BOUNDARY LAYERS IN MAGNETOGASDYNAMICS WITH PRESSURE GRADIENT AND HEAT TRANSFER. Spring, Francis Edward Jr. Tucson, Ariz., Univ. of Arizona, 1968. 151p.

Thesis.

General equations are obtained to describe the laminar supersonic flow of slightly ionized argon gas over a highly cooled flat plate in the presence of a transverse magnetic field. There is no applied electric field. Magnetic effects are present in both the viscous boundary layer and the inviscid region. The fluid is assumed to be a continuum, and the fluid properties are variable. Allowance is made for the possibility of Hall currents. Numerical results are obtained by a finite-difference digital computer program. An experimental analysis was also performed, using the flow of slightly ionized argon through a rectangular duct at supersonic velocities. Boundary layers on the duct walls influenced each other only at the corners. Pressure and temperature readings were used to obtain boundary layer growth and heat transfer rates. It was found, both theoretically and experimentally, that the boundary layer thickness is decreased somewhat by the application of the magnetic field. The heat transfer rate from the fluid to the plate is increased by the field. This agreement between theory and experiment occurs when the Hall effect is considered. If the Hall effect is neglected, theoretical pressure and temperature gradients are predicted which can not be justified experimentally. The results indicate that the Hall effect strongly influences the flow. If Hall currents are allowed to flow, as in this analysis, much smaller changes may occur in the fluid behavior than in the case where the Hall currents are restricted. (Disser. Abstr.)

5281 MAGNETOHYDRODYNAMIC FLOW PAST AXISYMMETRIC BODIES. Parbhakar, Kanwal Jit. Boulder, Colo., Univ. of Colorado, 1968. 115p.

Thesis.

The steady, axially symmetric flow of an inviscid, incompressible, conducting fluid, in the presence of an aligned magnetic field, past fixed bodies, semi-infinite and closed, is considered as a problem of finite perturbation. The conductivity is assumed to be small so that the external magnetic field is not perturbed by the motion: at the same time, the external field is assumed very strong so that when coupled with the small induced current it modifies the motion appreciably. This is particularly true in the immediate vicinity of the body. The nonlinear interaction between the flow field and the magnetic field depends on the parameter β which is essentially the product of the conductivity and the square of the applied magnetic field. This problem involves the solution of a boundary-value problem with an elliptic partial differential equation. An attempt is made to solve this problem numerically. A rectangular mesh is superimposed on the region of interest and the elliptic partial differential equation is reduced to a set of difference equations which are solved by iteration using successive over-relaxation technique. An artificial boundary is introduced and a check on the solution is made by shifting the boundary from its original position. An expansion in terms of the parameter β is used and up to the second-order correction to the nonmagnetic potential flow is calculated. The solution indicates the presence of a nondiffuse boundary layer and wake for the semi-infinite body and the closed body respectively. In fact, the effect of the body is felt upstream and is carried downstream in the form of a nondiffusive boundary layer or wake. This solution is used to calculate the drag, the boundary layer thickness, the displacement thickness, the momentum thickness, and the wake width. The various boundary layer and wake characteristics are found to decrease with the parameter β. The classical Bernoulli function H is found to decrease along the streamlines and the pressure distribution is calculated on the surface of the bodies. The pressure on the surface of the bodies changes appreciably as compared to the nonmagnetic pressure distribution. (Disser. Abstr.)

5282 EFFECT OF AN ELECTRIC FIELD ON A WEAKLY IONIZED GAS. II. INFLUENCE OF INELASTIC COLLISIONS ON THE "QUEUE" OF THE ELECTRON DISTRIBUTION FUNCTION: REGION OF THE THRESHOLD OF IONIZATION. Peyraud, Nelly (Laboratoire de Physique des Plasmas, Orsay, France). J. Phys. (Paris), 29: 747-58(Aug.-Sept. 1968). (In French).

In a previous paper, the problem of the determination of the "tail" of the electronic distribution function resulting from the balance between Joule effect and elastic and inelastic collisions was stated; a method of resolution of this problem for very high energies (asymptotic behavior) was given. In this paper, the "tail" of the distribution function in the neighborhood of the highest excitation threshold is determined, and the validity of the result is discussed for the case of atomic hydrogen. (auth)

Geophysics

Refer also to abstracts 5163, 5165, 5166, and 5202.

5283 UPPER ATMOSPHERE DURING GEOMAGNETIC DISTURBANCES. II. GEOMAGNETIC STORMS, OXYGEN EMISSION AT 6300 A AND HEATING OF THE UPPER ATMOSPHERE. Truttse, Yu. L. (Academy of Sciences, Moscow). Planet. Space Sci., 16: 1201-8(Oct. 1968).

The behavior of the oxygen emission at 6300 Å and the heating of the upper atmosphere during geomagnetic storms are compared. If the stability and the lowest value of the time lag are taken for the main criterion, the heating of the upper atmosphere is more clearly associated with D_{st} than with a_p indices. During very strong geomagnetic storms the energy lost by the upper atmosphere due to thermal conductivity downward is lower than that due to oxygen emission at 6300 Å. (auth) (UK)

5284 RESULTS OF SPACE RESEARCH: THE STORM OF JANUARY 13-14, 1967. TRW Space Log, 8: No. 3, 49-55(Fall 1968).

About 0200 UT on Jan. 11, 1967, an importance-3B flare erupted on the Sun, at 26° S and 47° W. The interplanetary storm that resulted hit the surface of the Earth at 1203 UT on Jan. 13, with an SC magnetic storm. The location and instrumentation of five spacecraft during this storm permitted a relatively complete measurement of the events and its evaluation as the strongest storm ever encountered in space. The storm led to major distortions of the Earth's magnetosphere and its compression to the lowest altitude ever recorded on the sunward side, lower than the synchronous satellite altitude of 22,225 statute miles. The data from many points in space and time measuring the qualities and sequences of this large-scale but unified event offered an excellent opportunity to clarify the dynamics of the solar wind, particularly of the boundary between the Earth and the wind. (W.D.M.)

5285 DETAILED MAPS OF TROPICAL 6300-A NIGHTGLOW ENHANCEMENTS AND THEIR IMPLICATIONS ON THE IONOSPHERIC F2 LAYER. Van Zandt, T. E.; Peterson, V. L. (Jicamarca Radar Observatory, Lima). Ann. Geophys., 24: 747-59 (July-Sept. 1968).

Detailed maps of enhancements of the 6300-Å nightglow from four nights of observations of Haleakala Observatory, Hawaii, are presented. They show that these enhancements can occur in a wide variety of forms, including a broad east–west band or arc, narrow north–south ridges arranged in an east–west band, intermediate forms, and irregular spots. The variation of intensity versus time was also different each night. These enhancements are caused largely by variations in the height of the F2 layer, the emission being brighter where the F2 layer is lower. Also, from observations made near the dip equator it is argued that the downward motions of the F2 layer are caused by westward electric fields (in contrast to the daytime equatorial anomaly, which is caused by an eastward field). Thus, the structure and physics of the nighttime, tropical F2 layer are much more complex than has been thought heretofore. (auth)

5286 LATITUDINAL MOVEMENTS IN THE AURORAL IONOSPHERE AS SHOWN BY SCINTILLATION MEASUREMENTS. Aarons, J. (Air Force Cambridge Research Labs., Bedford, Mass.); Mullen, J. P.; Silverman, H. M.; Steenstrup, Finn. Ann. Geophys., 24: 879-84(July-Sept. 1968).

Ionospheric irregularities in the F layer display both a diurnal and a magnetic storm pattern in their latitudinal variations in the auroral and subauroral regions. In scintillation measurements of the 40 MHz transmissions from S-66 taken at Narssarssuaq, Greenland and at Sagamore Hill, Massachusetts, the diurnal pattern for low magnetic indices was obtained. During daylight hours, the scintillation curtain is north of Narssarssuaq with the boundary between 75° to 80° geomagnetic north. After sunset, the boundary moves south of Narssarssuaq. There is evidence that the irregularity layer is both thicker and lower in the auroral zone during the night hours. Comparing similar time periods, it was found that during magnetic storms the boundary of the curtain moves away from the auroral zone in a manner similar to that of the optical and radio aurora. The evidence is that the latitudinal variations of the irregularity structure are closely correlated with low-energy (few keV) electrons in both their time patterns and their magnetic storm variations. (auth)

5287 ELECTRON CONTENT LATITUDE DEPENDENCE MARCH 1966 PERIOD. Klobuchar, J. A.; Aarons, J. (Air Force Cambridge Research Labs., Bedford, Mass.). Ann. Geophys., 24: 885-8(July-Sept. 1968).

Observations were made from three northern hemisphere stations during March 1966 to determine the latitude dependence of total electron content. Values for some passes of the satellite were obtained from 5 to 70°N latitude. The differential Faraday technique was used. Over the latitude range of observations, total electron content generally decreased with increasing latitude, with steeper gradients occurring during the hours nearer noon. Slab thickness values, however, were constant or increased with latitude, indicating that the height gradient of electron density was considerably less in northern latitudes than at low latitudes. The March 1966 magnetically disturbed periods were studied for changes in total electron content. With the available data, no significant changes in total electron content were noted at the latitudes studied. (auth)

5288 IONOSPHERIC EFFECTS OF AN ACOUSTIC WAVE. Broche, P. (Laboratoire de Physique de l'Exosphere, Paris). Ann. Geophys., 24: 723-9(July-Sept. 1968). (In French).

It is shown that, when an acoustic wave propagates through the ionosphere, an electrostatic polarization field is established instantaneously. Its effect on the velocity of the ionization is then calculated: for a vertical magnetic field, this velocity is found to be vertical from the lower ionosphere upwards. For an inclined field, and for a conical wave, the velocity is approximately in the magnetic meridian. In the F region, the polarization field is negligible and the velocity is always parallel to the magnetic field. (auth)

5289 CALCULATION OF VARIATIONS OF THE OPTICAL PATH AND EMERGENCE CONDITIONS IN A DYNAMIC IONOSPHERE. Crochet, M. (Laboratoire de Physique de l'Exosphere, Paris). Ann. Geophys., 24: 731-9(July-Sept. 1968). (In French).

Phase path variations for oblique propagation of hf radio waves were computed directly for variations of the parameters defining a parabolic ionospheric layer. Results are given as functions of group path to facilitate the analysis of Doppler frequencies observed in signals obtained by the ionospheric ground backscatter method. Emergence parameters of a radio wave refracted by an ionospheric layer with horizontal gradients are shown to be closely connected to phase path variations relative to the wave. A knowledge of the Doppler frequencies and of the longitudinal and transverse velocities of the gradients thus leads to the indirect determination of the angle of emergence. (auth)

5290 OUTER ZONE ELECTRON FLUXES DURING THE FEBRUARY 5, 1965, SOLAR PROTON EVENT. Lanzerotti, L. J. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Ann. Geophys., 24: 847-55(July-Sept. 1968).

The solar-wind plasma accompanying the solar-proton event on Day 36, 1965, produced a sudden commencement magnetic storm observed on Earth on Day 37, 1965. The effects of the magnetic storm on the low-latitude outer-belt electrons ($E_e >$ 0.3, > 0.45 and > 1.0 MeV) as observed by the Explorer 26 satellite are studied at L = 4.0, 4.5, and 5.0 R_E. The time delay between the sudden commencement and the effects of the storm on the magnetosphere electrons is observed to be a function of both the electron L value and the electron energy. The storm is observed essentially simultaneously with the SC at L = 5.0 R_E for $E_e > 0.3$ MeV, while there is about a 30-hour time lag between the SC and the enhanced fluxes of electrons of $E_E > 1.0$ MeV at L = 4.0 R_E. The time behavior of the electron fluxes is correlated with the magnetic field index K_p, with the equatorial D_{st}, and with the auroral electrojet index A_E. The electron acceleration mechanism and the electron time correlations with other storm-induced effects are discussed in relationship to possible energy transfer mechanisms coupling the enhanced solar wind to the interior of the magnetosphere. (auth)

5291 OGO-2 MAGNETIC FIELD OBSERVATIONS DURING THE MAGNETIC STORM OF MARCH 13–15, 1966. Langel, R. A.; Cain, J. C. (Goddard Space Flight Center, Greenbelt, Md.). Ann. Geophys., 24: 857-69(July-Sept. 1968).

Magnetic field data from the OGO-2 spacecraft and from surface magnetic observatories were analyzed for the period March 13–15, 1966. During this interval there occurred a magnetic storm with a Dst decrease of 122 γ. The results indicate a nonsymmetric inflation of the magnetosphere (asymmetric ring current) with the field decrease in the dusk sector of about three more than that in the dawn sector. Within the 10 to 30 γ accuracy of the data, the field disturbance at the satellite was equal to that on the surface at the same local time. From this evidence it is concluded that the source of both Dst and Ds in low latitudes is external to the satellite altitudes (410 to 1510 km). The disturbance observed near the dusk meridian commenced several hours sooner than that observed near the dawn meridian, reached its maximum intensity in 18 hours and then decayed in another 18 hours to the level seen on the dawn meridian. Polar ionospheric currents were detected more than 1.5 hour before the storm's main phase. These currents conform to the classical "twocelled" model which includes a concentrated eastward current in the evening local time sector and a concentrated westward current in the morning local time sector. The evening currents first appear at L = 7.5 and smoothly shift to L = 4.3 at the time of maximum Dst. The morning currents first appear at L = 7.9 and subsequently shift to L = 5.3. The L location of the morning currents is always greater than that of the evening currents. These currents decrease at least by an order of magnitude at the same time as the transition from asymmetric to symmetric inflation is seen at low latitude. (auth)

5292 MICROSTRUCTURES AT VARIOUS LATITUDES AND SPECTRAL COMPOSITION OF MAGNETIC PERTURBATIONS OF FEBRUARY 1965 AND MARCH 1966. Glangeaud, F.; Roquet, J.; Selzer, E. (Institut de Physique du Globe, Paris). Ann. Geophys., 24: 871-7(July-Sept. 1968). (In French).

The principal results of an investigation of the various geomagnetic events which occurred during February 1965 and March 1966 are presented. For this purpose, registrations of magnetic variations at most of the stations of the former French IGY network were available, as well as registrations from the Addis Ababa Observatory. Such a network has the advantage of being provided with a very complete and homogenous set of variometers, including, besides the classical magnetographs, "bars-fluxmeters" equipment, and ultrarapid and sensitive sets (30 and 60 mm/mn and 0.002 γ/mm). Moreover, a magnetic-tape registration in permanent operation at Chambon-la-Forêt, permits a spectral analysis of all magnetic variations between 0.02 and 2 c/s. Although the main purpose of the study was devoted to microstructure analyses, the authors have directed their investigations in trying to bring out the often-complex relationships which can exist between the various microvariations and the more classical corresponding macroscopic events. Confrontation of pre-existing general knowledge on this subject, and the precise facts which were examined in the course of the present work, although not showing any capital discrepancies, have brought interesting material for further studies. (auth)

5293 PRELIMINARY RESULTS OF MICROPULSATION STUDIES AT MAGNETOCONJUGATE POINTS IN THE ARCTIC AND ANTARCTIC. Troitskaya, V. A. (Inst. of Physics of the Earth, Moscow); Bolshakova, O. V.; Hessler, V. P. Ann. Geophys., 24: 741-6(July-Sept. 1968).

Identical induction magnetometers have been in operation near the geomagnetic poles, at Vostok and Thule, since December 1964. Preliminary studies of data from these stations in comparison with lower-latitude stations are presented. The pronounced magnetoconjugate effects of the auroral zone fall off rapidly toward the poles. The Pc type of pulsations possess the same general form as at lower latitudes, and display pronounced diurnal and seasonal variation in incidence and amplitude. The amplitude of Pc 3 and Pi 2 at the poles is comparable to that of middle and low latitudes. A distinct residual activity is observed at the poles for $k_p = 0$. (auth)

5294 PROPAGATION OF SLOW WAVES IN A MOVING PLASMA. Gul'elmi, A. V. (Inst. of Physics of the Earth, Moscow). Ann. Geophys., 24: 761-3(July-Sept. 1968).

In a moving plasma an additional time delay for electromagnetic waves arises and distortion of their trajectory occurs. Common formulas describing these effects are advanced, and concrete examples related to the propagation of pearl pulsations, whistling atmospherics, and proton whistlers are discussed. (auth)

5295 STUDIES OF THE SUDDEN CHANGES IN H AT EQUATORIAL STATIONS IN AMERICAN ZONE. Rastogi, R. G.; Trivedi, N. B. (Physical Research Lab., Ahmedabad, India). Ann. Geophys., 24: 771-7(July-Sept. 1968).

Storm sudden commencements (SC) and sudden impulses (SI) in the horizontal component at equatorial stations in the American Zone during IGY/IGC are discussed. The occurrence of SI is most frequent around midday whereas distribution of SC frequency with local time is uncertain. The amplitude of both SC and SI at the equatorial stations are enhanced during daylight hours. At any particular hour the amplitudes are enhanced only over a narrow zone over the magnetic equator. The enhancement is identical for SC and SI. It is suggested that the mechanism for equatorial enhancement for SC and SI is the same. (auth)

5296 LUNAR TIDAL OSCILLATIONS IN H AT HUANCAYO DURING IGY/IGC. Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). Ann. Geophys., 24: 779-88(July-Sept. 1968).

Lunar daily variations of H at Huancayo during any of the seasons of IGY/IGC are shown to follow Chapman's phase law, viz., $L = \Sigma_{n=1}^{4} c_n \sin\{n\tau + (n-2)\nu + \alpha_n\}$. For a particular season, the phase of lunar semi-diurnal wave (L_2) remains constant while the amplitude increases with the increase of solar activity. The increase of lunar semi-diurnal wave is less than the corresponding increase of solar semi-diurnal wave with increasing solar activity. Lunar semi-monthly (M_2) tide in H at fixed solar times varies with the solar time in the same way as the electrojet current, i.e., the amplitude starts increasing with sunrise, reaches a maximum near noon and decreases to low value by sunset. The phase of lunar monthly (M_1) tide in H for a particular season is controlled by lunar age and not by lunar time. The lunar semi-monthly (M_2) tide in H for any hour of the daytime hours is maximum at the same lunar time for months September to April and at the same lunar age for months May to August. The lunar semi-diurnal (L_2) as well as the lunar semi-monthly (M_2) tide is larger during southern than during the northern solsticial months. It is suggested that the phase of lunar tides in H at the equatorial stations is caused by two independent sources controlled, respectively, by the lunar age and by the lunar time at the station, the amplitude being controlled by the local solar time, being maximum near local noon. (auth)

5297 METHOD OF DETERMINATION OF THE GROUP VELOCITY AND INDEX IN ANISOTROPIC MEDIA. Bitoun, Jacky; Graff, Philippe (CNET, Issy-les-Moulineaux, France). Ann. Geophys., 24: 789-91(July-Sept. 1968). (In French).

A practical method for the determination of the group velocity of waves in an homogeneous anisotropic medium is presented, by using an implicit function from the dispersion relation. As a numerical application, the value of the group velocity is computed without any approximation in the case of a cold magnetoplasma. (auth)

5298 MORPHOLOGY OF SOLAR AND GEOPHYSICAL ACTIVITY DURING FEBRUARY 1965 AND MARCH 1966. Lincoln, J. Virginia (World Data Center A, Boulder, Colo.). Ann. Geophys., 24: 793-8(July-Sept. 1968).

Solar and geophysical activities, as collated from worldwide sources of synoptic data, are summarized for the periods February 1965 and March 1966, which were selected to be the subject of the IAGA Symposium on Special Events, St. Gallen, Switzerland, October 2, 1967. (auth)

5299 IONOSPHERIC MEASURING PROBE. Miyazaki, Shigeru; Mori, Hirotaka. Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 4: 226-36(Apr. 1968). (In Japanese).

A method is described by which the electron density, electron temperature, ion density, ion composition, ion temperature, and plasma space potential relative to space vehicle potential are measured by means of a spherical probe assembly. This method represents an improvement over previous methods in that it allows exact comparisons between the parameters involved. (IAA)

5300 EFFECT OF SOLAR ACTIVITY ON THE S_q-VARIATIONS OF THE GEOMAGNETIC FIELD. Chikovani, Dzh. S. (Inst. of Geophysics, Tiflis, USSR). Soobshch. Akad. Nauk Gruz. SSR, 50: 71-6(Apr. 1968). (In Russian).

A study was made of the dependence of quiet diurnal variations in the geomagnetic field on solar-activity variations as measured at the Dushet magnetic observatory during the last solar cycle. Average values of 34 and 36 γ were obtained for the high-solar-activity period and the low-solar-activity period, respectively. Variations in solar activity were found to produce no effect on the time of occurrence of daily extrema in $S_q(H)$ variations. A tendency toward recurrence in roughly 28-day cycles was established in the incidence of magnetic disturbances and other geomagnetic phenomena related to solar activity. (IAA)

5301 FADING CHARACTERISTICS OF RADIO WAVES IN THE E REGION OF THE IONOSPHERE OVER AHMEDABAD AND THUMBA DURING IQSY. Rastogi, R. G. (Physical Research Lab., Ahmedabad, India); Deshpande, M. R.; Kaushika, N. D. J. Inst. Telecommun. Eng., 14: 85-8(Feb. 1968).

A measurement was made, using Mitra's (1949) method, of the fading characteristics of radio waves in the E region of the ionosphere over Ahmedabad and Thumba. It was found that the rate of fading at Thumba is higher than that at Ahmedabad. The probability distributions of amplitudes at Ahmedabad follow either Rayleigh or Gaussian law whereas at Thumba neither of these was observed; in most cases for Thumba, it was exponential. (IAA)

5302 RADIAL DIFFUSION COEFFICIENT FOR ELECTRONS AT $1.76 < L < 5$. Newkirk, L. L.; Walt, M. (Lockheed Research Lab., Palo Alto, Calif.). J. Geophys. Res., 73: 7231-6(Dec. 1, 1968).

Radial diffusion by nonconservation of the third adiabatic invariant of particle motion is assumed in analyzing experiments in which electrons appeared to move across the field lines. Time-dependent solutions of the Fokker–Planck diffusion equation are obtained numerically and fitted to the experimental results by adjusting the diffusion coefficient. Values deduced for the diffusion coefficient vary from 1.3×10^{-5} R_E^2/day at $L = 1.76$ to 0.10 R_E^2/day at $L = 5$. In the interval $2.6 < L < 5$, the coefficient varies as $L^{10\pm1}$. Assuming a constant electron source of arbitrary magnitude at $L = 6$ and the above diffusion coefficients, the equatorial equilibrium distribution is calculated for electrons with energies above 1.6 MeV. The calculation yields an outer belt of electrons whose radial distribution is in good agreement with the observed belt. The calculated distribution also exhibits an inner belt at $L \approx 1.5$. However, the calculated intensity of the inner belt relative to the outer belt is several orders of magnitude smaller than the experimental ratio. (auth)

5303 DEPENDENCE OF THE HIGH-LATITUDE ELECTRON ($E > 35$ keV) BOUNDARY ON THE ORIENTATION OF THE GEOMAGNETIC AXIS. McDiarmid, I. B.; Wilson, Margaret D. (National Research Council of Canada, Ottawa). J. Geophys. Res., 73: 7237-44(Dec. 1, 1968).

Results of a preliminary study are given in which a dependence is observed between Λ_b, the average high-latitude boundary of 35-keV electrons, and ϕ, the angle between the Earth–Sun line and the geomagnetic axis. The variation of Λ_b with ϕ has a minimum near $\phi \sim 90°$ and is approximately symmetric about this angle. The maximum variation of the average Λ_b with ϕ is between 2° and 3°. There is some indication that the dependence of Λ_b on ϕ is greatest in the morning hours, although this conclusion has to be regarded as tentative at present. The results are interpreted as indicating a stronger coupling between the solar wind and the magnetosphere when $\phi \sim 90°$, which results in more geomagnetic flux being swept back into the tail at these times. (auth)

5304 HIGH-LATITUDE OUTER-ZONE BOUNDARY REGION FOR ≥ 40-keV ELECTRONS DURING GEOMAGNETICALLY QUIET PERIODS. Fritz, Theodore A. (Univ. of Iowa, Iowa City). J. Geophys. Res., 73: 7245-55(Dec. 1, 1968).

The relationship of locally mirroring and precipitating ≥ 40-keV electrons was studied on magnetically quiet days in the region of the high-latitude outer-zone boundary with satellite Injun 3. There was usually an enhancement of precipitating ≥40-keV electrons observed in the region of the high-latitude boundary for all local times. On the night side the flux of ≥40-keV electrons was always observed to approach isotropy over the upper hemisphere at the position of the satellite in this boundary region. The condition of isotropy in the boundary region was found to be strongly dependent on local time, being always present on the night side and being less-frequently observed with increasing local time around to local dusk (1800 hours) where isotropy was seldom observed in the boundary region. During magnetically quiet periods large intensities of ≥40-keV electrons were observed precipitating into the atmosphere for $\Lambda \geq 65°$, and the position of the high-latitude boundary (intensity cutoff) was observed to vary by $\Delta\Lambda \approx 7°$ while little magnetic activity was occurring. On the night side, the latitude where the ratio of the trapped to the precipitated ≥40-keV electron fluxes breaks toward one (φ boundary) is introduced as a more meaningful concept of the high-latitude limit to durably trapped ≥40-keV electrons than the usual intensity cutoff. The concept that the high-latitude outer-zone boundary region at all local times is controlled or driven by a mechanism(s) acting primarily on the night side is introduced. (auth)

5305 INTERACTION OF THE SOLAR WIND WITH THE MOON AND FORMATION OF A LUNAR LIMB SHOCK WAVE. Hollweg, Joseph V. (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 73: 7269-76(Dec. 1, 1968).

The interaction of the solar wind with a two-layered moon is considered from the point of view of the induction generator model of Sonnett and Colburn (1967). It is shown that a highly conducting lunar core, shielded by a thin insulating outer layer, cannot reasonably be consistent with the observed absence of a lunar bow shock, since a 10-m-thick surface dust layer would require a conductivity less than 10^{-10} mho/m, while a 10-km-thick layer would require a conductivity less than 10^{-7} mho/m to shield the core; conductivities in this low range do not seem reasonable. Thus an upper limit of 10^{-5} mho/m is established for the core conductivity, but it is pointed out that this figure can be consistent with the existence of a highly conducting surface layer. Two mechanisms are suggested for the formation of a lunar limb shock wave. It is shown that in the steady-state unipolar generator a limb shock will be expected to form in the vicinity of the plane defined by the solar wind velocity and magnetic field directions, while a limb shock may be expected to form also in the nonsteady state if the moon possesses a conducting outer layer ($10^{-4} < \sigma < 10^{-3}$ mho/m) of thickness between one-tenth and several kilometers. (auth)

5306 LUNAR WAKE AT LARGE DISTANCES. Michel, F. C. (Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 7277-83 (Dec. 1, 1968).

The expected properties of the lunar wake at large distances are examined in light of the Explorer 35 data on the solar wind interaction with the moon. It is concluded that any geomagnetic activity expected by means of the interaction of this wake with the magnetosphere would be below the limit of detectability by present methods. It is also concluded on the basis of energy conservation that the December 14–15, 1963, disturbance observed on Explorer 18 and interpreted by Ness to the wake of the Moon was actually a disturbance already in the solar wind itself and not generated by the Moon, although the very mild disturbance of February 11, 1964, might be attributed to the lunar wake, as was suggested by Ness. The December disturbance involved at least two orders of magnitude more disturbance energy than could be generated by a lunar source. The February disturbance is quantitatively consistent with turbulence being present in the lunar wake. (auth)

5307 LANGMUIR PROBE EVIDENCE FOR A NOCTURNAL IONIZATION SOURCE AT FORT CHURCHILL. Walker, James C. G. (Yale Univ., New Haven); Brace, L. H.; Rees, M. H. J. Geophys. Res., 73: 7285-90(Dec. 1, 1968).

Electron concentrations and temperatures measured in a nocturnal rocket flight (NASA 1802) at Fort Churchill, Manitoba, were considerably higher than nocturnal values measured at lower latitudes, particularly in the F region. This is attributed to a high-latitude energy source provided by bombardment of the atmosphere by energetic auroral electrons. By calculating the ionospheric electron concentrations and temperatures that result from auroral bombardment one can deduce the flux and energy spectrum of the incident particles. The ionospheric data correspond to a bombarding flux of 1.25×10^9 electrons cm^{-2} sec^{-1} with a mean energy of 1.2 keV. Other data indicate that weak auroral bombardment and enhanced electron concentrations in the E and F1 regions are permanent features of the nocturnal auroral oval. (auth)

5308 MASS SPECTROMETRIC STUDIES OF THE COMPOSITION OF THE LOWER THERMOSPHERE DURING SUMMER 1967. Krankowsky, D.; Kasprzak, W. T.; Nier, Alfred O. (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 73: 7291-7306(Dec. 1, 1968).

The atmospheric composition in the altitude range between 120 and 210 km over White Sands, New Mexico was measured by mass spectrometers in three rocket flights at 1249 MST on June 21, 1967, and at 0200 MST and 1224 MST on July 20, 1967. The day-to-night variations of the ambient number densities found are larger than the model predictions and extend down to 120 km. Diffusive equilibrium profiles for the atmospheric constituents are compared with the measured number densities. The level where the Ar/N_2 ratio reaches the ground level value was computed to be at 99, 99, and 101 km for the three flights, respectively. The He number densities, when compared with results obtained in earlier flights, indicate a seasonal decrease of the He content from the winter to the summer by a factor of about 10. (auth)

5309 TWO-DIMENSIONAL CHAPMAN–FERRARO PROBLEM WITH NEUTRAL SHEET. I. THE BOUNDARY. Unti, T.; Atkinson, G. (California Inst. of Tech., Pasadena). J. Geophys. Res., 73: 7319-27(Dec. 1, 1968).

An exact solution to a two-dimensional magnetosphere with tail and neutral sheet using the Chapman–Ferraro approximation was found by mapping in the potential plane. The magnetic flux in the tail is an arbitrary parameter of the problem. Boundary and neutral sheet configurations are presented for several values of tail flux. It is found that the position of the neutral sheet and its return current on the outer boundary is very sensitive to the amount of magnetic flux in the tail. The relationship with the three-dimensional case is discussed, and it is concluded that the neutral sheet probably moves in and out by several R_E. This suggests the following large-scale convective flow pattern for the magnetosphere. Between magnetospheric substorms, field lines are carried into the tail, which causes an increase in tail flux, an inward motion of the neutral sheet, and a two-celled ionospheric current system. The magnetospheric substorm then chops off the inner edge of the neutral sheet, returning the system to its initial topology. (auth)

5310 AVERAGE MAGNETIC FIELD CONFIGURATION OF THE OUTER MAGNETOSPHERE. Fairfield, D. H. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 7329-38(Dec. 1, 1968).

Over 1500 hours of data from the satellites IMP 1, 2, and 3 were used to study the configuration of the magnetic field in the outer magnetosphere between 5 and 18 R_E. Hourly average field vectors were projected in the solar magnetic equatorial plane and in 24 meridian sections corresponding to each hour of local time. The plots show the sweeping back of the field toward the tail and the dawn and dusk transition from compressed dayside field lines to extended nightside field lines. Constant B contours in the equatorial plane were constructed, and flux conservation was used to establish a quantitative relationship between the equatorial crossing point of an outer magnetosphere field line and the latitude of its Earth intersection. A contour diagram in the equatorial plane designating the latitude of field line origin permits the mapping of low-altitude phenomena to the equatorial plane and vice versa. Auroral oval field lines are found to come from the region of the magnetopause in the daylight hemisphere but from well within the magnetosphere in the night hemisphere. The outermost closed field line is found to come approximately 78° throughout the dayside hemisphere. (auth)

5311 SIMULTANEOUS OBSERVATIONS OF ELECTRONS (E > 45 keV) AT 2000-KILOMETER ALTITUDE AND AT 100,000 KILOMETERS IN THE MAGNETOTAIL. Hones, E. W., Jr. (Los Alamos Scientific Lab., N. Mex.); Singer, S.; Rao, C. S. R. J. Geophys. Res., 73: 7339-59(Dec. 1, 1968).

Geiger counters on Injun 4 and on Vela 2A, 2B, 3A, and 3B have provided simultaneous measurements of energetic electron fluxes ($E_c > 45$ keV) at ~2000-km altitude over the auroral and polar regions and at ~17 R_E in the plasma sheet of the magnetotail. The data discussed here were obtained in March, April, September, and October 1965 periods when Injun 4 crossed the northern auroral zone between 1600 and 2400 magnetic local time (MLT) and between 0400 and 1200 MLT. The Injun measurements confirm a recent report that the peak flux of electrons in the outer belt in the late morning hours often is substantially increased shortly after the onset of a magnetic bay in the midnight sector of the auroral zone. They show, in addition, that the early evening sector of the outer belt does not respond promptly in this way to a bay. This difference in response supports the view that the electrons that enhance the morning sector of the outer belt are injected by some process acting in the midnight sector of the magnetosphere. The Vela measurements confirm an earlier report that an essentially isotropic flux of energetic electrons appears in the plasma sheet, generally after the peak of a bay. Furthermore, the concurrent measurements by Vela and Injun 4 show that the flux of electrons in the plasma sheet after a bay is usually much less intense than the peak flux attained in the outer zone after the same bay. Both the delayed appearance of the electrons in the magnetotail and their relatively lower intensity imply that the energization process acts not in the very distant tail, but closer to the Earth than 17 R_E. It is suggested that electron energization (along with a general heating of the ambient plasma) takes place within the auroral and/or outer-zone tubes of force during a bay and that these tubes do not extend as far as 17 R_E into the tail during the energization process. Movement of the hot plasma to the distant tail signals the start of recovery of a bay and results in the bursts of energetic electrons seen in the tail. Thus, the distant tail is not a source of energetic (>45-keV) outer-belt electrons, but an additional sink for the process that generates them. It is argued, on the basis of these and other observations, that some process other than merging of magnetic field lines is primarily responsible for generation of the energetic electrons. (auth)

5312 ION CUTOFF WHISTLERS. Muzzio, J. L. R. (Stanford Univ., Calif.). J. Geophys. Res., 73: 7526-9(Dec. 1, 1968).

A new phenomenon associated with the propagation of whistlers in the ionosphere has been found in recordings of the Stanford vlf experiments aboard satellites OGO 2 and OGO 4. On a frequency–time spectrogram, this phenomenon manifests itself by the turning up of a whistler trace as a frequency below 1 kHz. This phenomenon is illustrated and discussed. (W.D.M.)

5313 MIDLATITUDE NIGHTTIME TOTAL ELECTRON CONTENT BEHAVIOR DURING MAGNETICALLY DISTURBED PERIODS. Klobuchar, J. A.; Aarons, J.; Hosseinieh, H. Hajeb (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res., 73: 7530-4(Dec. 1, 1968).

Since the summer of 1967, nearly continuous measurements of the total electron content (TEC) of the ionosphere have been taken at Sagamore Hill by measuring the Faraday rotation of the plane of polarization of vhf radio waves transmitted from Canary Bird. After the launch of ATS 3 in November 1967, measurements of Farraday rotation of vhf signals from it were also begun so that the TEC along two oblique, stationary paths from the same ground location could be determined. The winter nighttime behavior along the two paths, particularly the anomalous observed increases in TEC during the night, is discussed. (W.D.M.)

5314 DISCUSSION OF PAPER BY C. F. KENNEL AND R. Z. SAGDEEV, "COLLISIONLESS SHOCK WAVES IN HIGH β PLASMAS, 2". Macmahon, Alan B. (Univ. of Texas, Austin). J. Geophys. Res., 73: 7538-9(Dec. 1, 1968).

It is pointed out that the finite cyclotron radius approximation made by Kennel and Sagdeev (1967) is inconsistent, and that for most ion distribution functions the phase velocity is actually decreased at short wavelengths. A comment by Kennel indicates that this is correct. (W.D.M.)

5315 DISCUSSION OF LETTER BY A. J. FERRARO AND H. S. LEE, "CAPABILITY OF A HIGH-POWER WAVE INTERACTION FACILITY". Gregory, J. B.; Manson, A. H. (Univ. of Saskatchewan, Saskatoon). J. Geophys. Res., 73: 7540-3 (Dec. 1, 1968).

The purpose of this Letter is to comment on apparent difficulties experienced by some workers in obtaining D-region electron concentrations from the partial reflection experiment (Gardner and Pawsey, 1953). In particular, a misquotation by Ferraro and Lee (1968) which gives the impression that a low-power partial reflection experiment is not satisfactory for D-region studies is corrected. A reply by Ferraro and Lee is included. (W.D.M.)

5316 BOUNCE RESONANT SCATTERING OF PARTICLES TRAPPED IN THE EARTH'S MAGNETIC FIELD. Roberts, Charles S.; Schulz, Michael (Bell Telephone Labs., Murray Hill, N. J.). J. Geophys. Res., 73: 7361-76(Dec. 1, 1968).

If a trapped particle is subjected to fluctuating forces with components parallel to the Earth's magnetic field, there can occur a resonant interaction that violates the particle's second, or longitudinal, adiabatic invariant. Such forces may be produced by small fluctuation magnetic or electric fields (plasma turbulence) in the compressional Alfvén mode (fast mode) or the ion acoustic mode (slow mode). Power in the turbulence spectrum at the particle's bounce frequency and its harmonics contributes to bounce resonant scattering. The Fokker–Planck equation may be used to describe the resulting redistribution of particles' longitudinal invariant values due to bounce resonance, or equivalently, the diffusion may be described in terms of the particles' equatorial pitch angles. The scale of spatial variations of the plasma turbulence is of importance in determining the falloff of the Fokker–Planck diffusion coefficient with increasing mirror point distance from the magnetic equator. It is found that a magnetic fluctuation power spectrum having a power density at the bounce frequency of approximately 10^{-8} Hz^{-1} (in units of the equatorial field magnitude B_0 on the line of force of interest) suffices to account for the experimentally observed pitch-angle diffusion of Van Allen electrons mirroring within 5° latitude of the magnetic equator. This power level corresponds very roughly to a root mean square magnetic fluctuation above the bounce frequency of only 10^{-4} B_0. If such magnetic fluctuations are actually present in the magnetosphere and if cyclotron resonant scattering can account for the pitch-angle diffusion of electrons mirroring past 5° latitude, then the observed loss of Van Allen electrons due to pitch-angle diffusion into the loss cone may be explained by a dual mechanism, a combination involving both bounce and cyclotron resonance. Better experimental measurements on the spectrum of the turbulence in the magnetosphere are needed to confirm or disprove this or any other proposed pitch-angle diffusion mechanism. (auth)

5317 ELECTRON PRODUCTION AND LOSS RATES IN THE F REGION. Smith III, F. L. (Stanford Univ., Calif.). J. Geophys. Res., 73: 7385-98(Dec. 1, 1968).

Accurate measurements of the amount of Faraday rotation imposed on vhf telemetry transmissions from a geostationary satellite were analyzed to study rates of production and loss of electrons in the F region of the ionosphere. The rate of photoionization of atomic oxygen, integrated with respect to height through the ionosphere, was determined at sunrise over Hawaii. The analysis also yielded the magnitude of the linear loss coefficient at an altitude of 300 km. The integrated rate of production of O^+ ions at sunrise was used to deduce the total flux of solar euv radiation in the 165 to 911Å wavelength range incident on the earth's atmosphere. Atomic oxygen photoionization rates and solar euv flux values were obtained on a daily basis, and loss coefficients were obtained on a monthly average basis, over the 2-year period extending from September 1964 through August 1966. The integrated rate of production of O^+ was found to average 1.7×10^9 ions/cm^2 sec at sunrise over Hawaii. The flux of solar euv radiation incident on the atmosphere was found to average 4.5×10^{10} photons/cm^2 sec. The loss coefficient averaged 1.4×10^{-5} sec^{-1} at an altitude of 300 km. No seasonal variation was observed in the integrated O^+ production rate, but the loss coefficient had a winter-to-summer variation of about 2:1. (auth)

5318 NIGHTTIME VARIATIONS OF F-REGION ELECTRON DENSITY PROFILES AT PUERTO RICO. III. SEASONAL AND SOLAR CYCLE VARIATIONS IN TEMPERATURE AND VERTICAL DRIFT VELOCITY DEDUCED FROM IONOSPHERIC DATA. Shimazaki, Tatsuo; Laird, A. R. (Ionospheric Telecommunications Lab., Boulder, Colo.). J. Geophys. Res., 73: 7399-7406 (Dec. 1, 1968).

A method developed in Part 2 (Shimazaki, 1966) to calculate nighttime variations in the "effective temperature" and vertical drift velocity from the F-region electron density profiles obtained from radio soundings was applied to observational data of various seasons and years at Puerto Rico. Seasonal and solar cycle variations in temperature calculated in this study are reasonable, but differ quantitatively from those obtained from satellite drag data. The result indicates that the summer temperature is higher than the winter one by ~100°K for the same solar activity, while the annual temperature decreases by 200 ~ 300°K with the decrease of sunspot activity from 1959 to 1961. There is no systematic seasonal and solar cycle variation in the prevailing and semidiurnal component of variations in the vertical drift velocity except that the downward prevailing component is appreciably larger in winter than in summer in years of higher sunspot activity. In its nocturnal variations, the temperature tends to rise before sunrise; the onset time and the magnitude of the increase depend upon the season. It is suggested, on the basis of backscatter observations of T_e, T_i and $\overline{m}_i$, that the predawn increase of the "effective temperature" represents a departure from the atmospheric temperature. (auth)

5319 TRANSPOLAR EXOSPHERIC PLASMA. I. PLASMASPHERE TERMINATION. Thomas, J. O.; Andrews, M. K. (Imperial Coll. of Science and Tech., London). J. Geophys. Res., 73: 7407-17(Dec. 1, 1968).

From an examination of many transpolar exospheric electron concentration distributions along tracks of the Alouette 1 satellite at a fixed direction to the Earth–Sun line, it is found that there is an approximately characteristic profile for a given direction. It is suggested that this implies a fixed concentration distribution over the polar regions under which the Earth rotates. If it is assumed that the ionospheric trough at high latitudes is a demarcation between solar-produced ionization lying inside the plasmasphere and aurorally associated ionization at high latitudes, the midlatitude termination is the low-latitude wall of the trough. From a study of many topside sounder records obtained during the polar winter, the position of this termination is located at the F peak at all local times, and its motions investigated. Its position is found to be clearly defined and correlated with Kp in the 1800 LT region, when the plasmapause is most unstable. However, when the trough is compared with the position of the plasmapause projected back along field lines, systematic differences in position are apparent that may be related to field line distortions in the magnetosphere. (auth)

5320 EFFECT OF ABSORPTION BY ATOMIC OXYGEN AND ATOMIC NITROGEN LINES ON UPPER ATMOSPHERE COMPOSITION MEASUREMENTS. Huffman, R. E.; Larrabee, J. C. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res., 73: 7419-28(Dec. 1, 1968).

The possibility of absorption of solar emission lines by absorption line series of oxygen and nitrogen atoms was examined in the 580 to 1306 Å wavelength region by utilizing new atomic lines recently observed in laboratory spectra as well as previously known transitions. For atomic oxygen, 41 solar lines are likely to be affected, and for atomic nitrogen there are eight

possibilities. These solar lines are to be avoided in atmospheric composition work, since the curves of intensity with altitude will be difficult to interpret. Discrete absorption by excited N_2 and O_2 molecules is also discussed. (auth)

5321 LOW-FREQUENCY CUTOFF OF ELF EMISSIONS. Gurnett, Donald A.; Burns, Thomas B. (Univ. of Iowa, Iowa City). J. Geophys. Res., 73: 7437-45(Dec. 1, 1968).

Elf and vlf radio noises observed by satellites in the ionosphere often have a very sharp lower cutoff frequency near the proton gyrofrequency. This paper summarizes the experimentally observed characteristics of this low-frequency cutoff and proposes an explanation for the cutoff based on the reflection of downward-propagating, extraordinary mode, waves near the two-ion cutoff frequency between the proton and helium gyrofrequencies. This explanation, if correct, provides the first direct evidence that chorus and elf hiss emissions are generated at high altitudes (above 3000 km) and not near the base of the ionosphere. Ground-based observations of 700-Hz noise bands near the auroral zone, previously attributable to proton cyclotron radiation at low altitudes in the ionosphere, can now be explained by this reflection mechanism. Other possibly related effects (such as multiple elf noise bands and the reflection of whistlers at the two-ion cutoff frequency) are discussed. (auth)

5322 NEW INTERPRETATION OF VLF CHORUS. Swift, Daniel W. (Univ. of Alaska, College). J. Geophys. Res., 73: 7447-56(Dec. 1, 1968).

It is suggested that the auroral-zone chorus is generated by an electrostatic loss-cone instability associated with ring-current protons. A dispersion relation is derived for the loss-cone instability in a tenuous cold plasma of the upper ionosphere and a much less dense ring-current plasma. It is shown that only harmonics of the ion gyrofrequency are excited and that the lowest order of the allowed harmonics is the most strongly excited. The observed dispersion in chorus emissions may be due to the convective instability propagating into regions of greater magnetic field strength. The wave is capable of accelerating electrons to energies of tens of keV, so that the processes responsible for chorus emission may also represent an accelerating mechanism for energetic electrons. It is suggested that the morphology of chorus is controlled by time-varying magnetospheric electric fields and the region of injection of ring-current particles into the magnetosphere. (auth)

5323 MECHANISM FOR VLF EMISSIONS. Das, A. C. (Imperial Coll. of Science and Tech., London). J. Geophys. Res., 73: 7457-71(Dec. 1, 1968).

The triggering of emissions, particularly by Morse pulses, is considered. Because it seems unlikely that linear theory can account for triggered emissions, the nonlinear effect of the pulse on the electron distribution is studied. This is an isolated but complicated theoretical problem, and some approximations are made. The approach aims at calculating the growth rate as a function of frequency for the disturbed plasma after the pulse has passed. The concepts of Kennel and Petschek (1966) are used, and the "diffusion curves" in velocity space along which the electrons are diffused are calculated. Also following Kennel and Petschek it is assumed that the background hiss can be amplified in a narrow band to give a discrete emission. The results are encouraging, particularly in explaining why dashes are so much more effective at triggering than dots. The mechanism discussed must occur, and orders of magnitude suggests that it is important. The mathematical treatment depends on the ratio of the duration of the pulse to the oscillation period for particles trapped by the wave, and this ratio may be of the order of unity. Here one crude model is presented appropriate to large values of this ratio (long strong pulses) and a less crude model is appropriate to small values (short weak pulses). Qualitatively the results are similar, and in particular they predict enhancements of the growth rate in narrow frequency bands at the edges of the spectrum of the triggering pulse. Qualitative discussion also indicates how hooks and risers can result in the nonuniform geomagnetic field, though the nonuniformity of the field is found to be unimportant in the treatment of the effect of the triggering pulse. (auth)

5324 THEORY OF HYDROMAGNETIC PROPAGATION IN THE IONOSPHERIC WAVEGUIDE. Greifinger, Carl; Greifinger, Phyllis S. (Rand Corp., Santa Monica, Calif.). J. Geophys. Res., 73: 7473-90(Dec. 1, 1968).

The propagation of low-frequency (Pc 1) hydromagnetic waves in the ionospheric duct, which results from the minimum in the Alfvén speed near the F2 ionization peak is considered. An inhomogeneous (in the vertical direction) waveguide in the presence of a uniform static magnetic field is assumed and the case of horizontal propagation in the plane of the magnetic meridian is treated. Propagation in the waveguide is governed by two coupled equations for the horizontal components of the electric field. For nighttime conditions, where the ionized region of interest starts at sufficiently high altitude that the collision frequency of ions with neutrals is small compared with the ion-cyclotron frequency, the two components become uncoupled, and only the isotropic, or fast wave, need be considered. For daytime conditions, however, coupling between the fast and slow waves must be taken into account; to simplify the analysis, the static field is assumed uniform in this case. To obtain analytic solution of the waveguide equations, it is necessary to have analytic approximations to the height dependence of the relevant ionospheric parameters; such approximations are constructed to fit some representative tabulated ionospheric profiles for a variety of conditions of time of day and sunspot activity. Solution of the waveguide equations subject to the appropriate boundary conditions results in a rather complicated dispersion relation between complex (horizontal) wave number and angular-frequency. The solutions of the dispersion relation prescribe the allowed bands of propagation in the guide. It is shown that each band, including the lowest, has a low-frequency cutoff, and that the existence of a low-frequency cutoff is a consequence of the boundary conditions and not of attenuation, as assumed in some theories. Numerical solutions of the dispersion equation are obtained for the two lowest bands for each of the conditions considered. From the dependence of the real part of the wave number on frequency, the cutoff frequencies and the phase and group velocities are determined, while the imaginary part provides the attenuation length. For nighttime conditions, attenuation is not large, and propagation can take place over distances of thousands of km, whereas daytime propagation is restricted by attenuation to distances of the order of hundreds of km. For nighttime minimum conditions, the calculated waveguide cutoff is about 0.4 cps, and the group velocity for the lowest band is about 720 km/sec, both in reasonable agreement with experiment. Finally, it is pointed out that there is an effective high-frequency "cutoff" (in any band) as far as ground-level signals are concerned due to an exponential decrease of transmission coefficient with frequency at high frequencies. (auth)

5325 OCCURRENCES OF Pc 1 PULSATIONS IN THE COURSE OF MAGNETOSPHERIC SUBSTORMS. Wilhelm, Klaus (Max-Planck-Institut fuer Aeronomie, Lindau/Harz, Ger.). J. Geophys. Res., 73: 7491-7501(Dec. 1, 1968).

Frequency–time displays of geomagnetic pulsations recorded at Kiruna, Sweden, during the summer months of the years 1964 and 1965 revealed the appearance of Pc 1 pulsations in the 4-sec band with a pronounced maximum of occurrence in the daytime. Many of these events showed a repetitive structure with values of the repetition time and dispersion parameters that indicate a generation region on shells with L between 7 and 10. The Pc 1 pulsations were frequently accompanied by cosmic-noise absorption (CNA) and x-ray enhancements; however, the onsets of the pulsations and of the CNA do not in general coincide. A systematic variation with time was observed for the time difference between the onsets of the pulsations and the absorption. At 06 LT the CNA started about 1.5 hr earlier than the pulsations, and at 16 LT the CNA started about 0.5 hr later. Furthermore, a series of events on the days after the ssc of August 16, 1965, showed Pc 1 pulsations starting at Kiruna approximately 0.5 hr after the onset of negative magnetic bays at College, Alaska. The observations can be explained by the assumption that energetic electrons and protons are injected into the outer radiation zone on the night side of the Earth during a magnetospheric substorm and that these particles reach the day side by drift. If only magnetic gradient and curvature drift is considered, particles with energies near 100 keV on a shell with $L \approx 8$ are required for a quantitative description of the observations. (auth)

5326 LOW-ENERGY ELECTRONS ON THE DAY SIDE OF THE MAGNETOSPHERE. Vasyliunas, Vytenis M. (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 73: 7519-23 (Dec. 1, 1968).

The OGO 3 satellite has provided the first opportunity for a detailed mapping of the low-energy electron distribution in the day-side magnetosphere. This letter is a preliminary report on observations with the M.I.T. electron detector on OGO 3 within the magnetosphere from Aug. 1966 to Feb. 1967, during which time the satellite surveyed local times from ~18 through noon to ~4 hours. (W.D.M.)

5327 PARTICLE ACCELERATION BY ELECTROSTATIC WAVES WITH SPATIALLY VARYING PHASE VELOCITIES. Gary, S. Peter (Univ. of Iowa, Iowa City); Montgomery, David; Swift, Daniel W. J. Geophys. Res., 73: 7524-5(Dec. 1, 1968).

Results of numerical calculations connected with a mechanism recently proposed (Swift, 1968) for the acceleration of charged particles in a strong dc magnetic field are presented. An electrostatic plasma wave propagates nearly perpendicularly to the

magnetic field, and a weak density gradient exists parallel to the magnetic field. The wave propagates into the region of increasing plasma density at constant frequency and becomes more nearly perpendicular to the field, i.e., the component of the wave vector parallel to the field decreases slowly. (W.D.M.)

5328 IONIZING RADIATIONS AND VEHICLES WITH EXTRA-ATMOSPHERIC TRAJECTORIES. Venturini, J. Dominique. Doc-Air-Espace, 31-56(July 1968). (In French).

Examination is made of the sources of natural ionizing radiations affecting vehicles with extraatmospheric trajectories. The nature of these radiations is discussed, and the primordial part played by the Sun is cited. A certain number of indications are given concerning the space routes of radiations, the radiation belts surrounding the Earth, and the fluxes likely to be encountered in space. Because of their potentiality for defense against long-range ballistic missiles, the creation of artificial radiation belts by exploding a nuclear bomb at high altitude is discussed. After reviewing briefly the mechanisms of interaction of radiations with matter, the defects caused in materials by radiations are indicated, as well as the effects of radiations on electronic components and devices and on liquid propellants. A few examples of protection against radiations, obtained by interposing absorbent materials, are also given. (auth) (IAA)

5329 S_q VARIATION OF THE GEOMAGNETIC FIELD AT DUSHETI BETWEEN 1952 AND 1965. Chikovani, Dzh. S. (Inst. of Geophysics, Tiflis, USSR). Soobshch. Akad. Nauk Gruz. SSR, 48: 567-70(Dec. 1967). (In Russian).

The regularity in the distribution of eight different types of smooth quiet-day variations (S_q) of the geomagnetic field over the period from 1952 to 1965 was studied. A new classification of S_q variations is described which takes into account both the form of the variations and the time of onset of the maxima. The classification is intended for studying the diurnal variability of the S_q variations in subfocal latitudes and relating this variability to specific ionospheric conditions. It is shown that the fundamental type of diurnal variation in the months of June, July, August, and September is the polar type. The focus of the S_q currents during these months is south of Dusheti and remains stable in this position. The remaining months exhibit eight different types of variations, and the position of the focus is unstable. The probability of occurrence of these types of variations does not change with the solar activity cycle. (IAA)

5330 THE PROBLEM OF TRIPLING IN THE F2 LAYER OF THE IONOSPHERE. Sharadze, Z. S. (Tbilisi State Univ., Tiflis, USSR). Soobshch. Akad. Nauk Gruz. SSR, 48: 561-6(Dec. 1967). (In Russian).

The mechanism responsible for the occurrence of three or more signals reflected from the F2 layer of the ionosphere at low and midlatitudes was investigated. The penetration of electromagnetic waves through the ionospheric layer is often accompanied by a triple separation of the h'f curve, and the resulting third segment is termed the z component. Observational data obtained during the period from 1964 to 1965 were examined to determine the nature of this phenomenon. It is shown that there are two basic mechanisms for the triplet formation in the E2 layer: (1) the f_0 of the sporadic F2 layer coincides with f_xF2; and (2) the f_x of the F2 sporadic layer is absorbed, and f_0F2, f_0F2_s, and F_xF2 remain. The tripling effect in the F2 layer is often accompanied by short-term formations of the E_s layer and is most often observed in winter between 1000 and 1300 hours. (IAA)

5331 POSITIVE IONS IN THE TOPSIDE IONOSPHERE. Boyd, R. L. F.; Laflin, Susan (University Coll., London). Proc. Roy. Soc. (London), Ser. A, 307: 449-70(Nov. 26, 1968).

The satellite Ariel I, launched in April 1962, provided a survey of the topside ionosphere over a latitude range of ±55°. The measurements made by the ion energy spectrometer showed the ions O^+ and He^+ to be the major massive components of the ionosphere and enabled a global study of the composition over the northern summer of 1962 to be made. Publication of earlier analyses of parts of the data showed a diurnal and seasonal variation in the composition, a strong geomagnetic control, and a suggestion of a departure from hydrostatic equilibrium in the diffusive separation of the ions. This communication provides a definitive presentation of the computer analysis of nearly all of the ion composition data obtained by the energy spectrometer. It confirms and strengthens the earlier conclusions by the inclusion of much more data, and by its regression analysis in terms of geomagnetic latitude, altitude and local solar time. It also gives results of the total ionization density measurements and of a study of the effect of vehicle aspect on the data. (auth) (UK)

5332 HIGH POWER RADAR FOR IONOSPHERIC RESEARCH. Hey, J. S.; Roberts, J. B. G.; Taylor, G. N.; Watkins, C. D. (Royal Radar Establishment, Malvern, Eng.). Nature (London), 220: 865-8(Nov. 30, 1968).

An account is given of a new high power radar at Malvern that is being used to investigate the ionosphere by the incoherent scatter technique. (auth)

5333 POLARIZATION OF CERTAIN COMPONENTS OF NIGHT-SKY RADIATION SCATTERED BY THE TROPOSPHERE. Divari, N. B. (Odessa Polytechnic Inst.). Sov. Astron. AJ (Engl. Transl.), 12: 503-11(Nov.-Dec. 1968).

Translated from Astron. Zh., 45: 634-44(May-June 1968).

The Stokes parameters are evaluated for the zodiacal light, the night-sky airglow, the light of all stars fainter than 6^m, and the twilight glow, as scattered by the troposphere. The light scattered by the troposphere is shown to have a quite high degree of polarization and must be taken into account when analyzing polarization measurements of the zodiacal light. For this reason revisions should be made in data on the zodiacal-light intensity at the ecliptic pole obtained without allowance for the light from all sources of night-sky emission scattered by the troposphere. (auth)

Low-Temperature Physics

Refer also to abstracts 5489 and 5717.

5334 (BNL-12843) COMPOSITE MATERIALS. McInturff, A. D. (Brookhaven National Lab., Upton, N. Y.). [1967]. 17p. (CONF-680621-10). Dep. CFSTI.

From Conference on Superconducting Devices and Accelerators, Upton, N. Y.

A survey is presented of the state-of-art of superconducting composite materials for magnet use. The criteria for rating a material are listed: critical current density, magnetization, flux jump stability, and reproducibility. The fabrication of the alloys (Nb_3Sn and TiNb) is evaluated using the criteria, and it is pointed out that a treatment which increases the critical current density often leads to flux jump instability. The performance of the following composite types is discussed: stranded cable, filamentary or stranded composite, and multilayered composite. It is felt that multilayer composites containing only the superconductor in filament size with sufficient high-conductivity metal for flux-jump stability and for allowing several stable filament superconductors to undergo normal transitions and return to the superconducting state, are the answer for both ac and dc applications. (D.L.C.)

5335 (COO-1569-27) EXPERIMENTAL STUDIES OF LONG JOSEPHSON JUNCTIONS. Goldman, A. M. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). Mar. 1968. Contract AT(11-1)-1569. 7p. (CONF-680320-1). Dep. CFSTI.

From Conference on Fluctuations in Superconductors, Pacific Grove, Calif.

The I–V characteristic of a strongly coupled, current-biased $Sn/Sn_xO_y/Sn$ junction at 1.3°K in a magnetic field H = 11 G shows an infinite slope segment at V ~ 1.5 mV. The continuous variation with applied magnetic field of the voltage at which this anomaly occurs suggests that it is not a self-induced step. The dependence of the normalized ratio V/H for the infinite slope anomaly on magnetic field follows the function $\sqrt{1-(H_c/H)^2}$, where H_c is the smallest field at which the anomaly may be seen, indicating that the anomaly is associated with the mixed state–Meissner state transition at finite voltages. (D.L.C.)

5336 (UCRL-18437) THE SUPERCONDUCTING CRITICAL CURRENT AND CRITICAL FIELDS OF Nb_3Sn–NbC AND Nb_3Sn–Nb COMPOSITES. Jones, Russell Howard (California Univ., Berkeley). Sept. 1968. Contract W-7405-eng-48. 57p. Dep. CFSTI.

Thesis.

The critical currents and critical fields of a Type-II superconductor are dependent on certain microstructural aspects. These properties have been studied using composite samples with Nb_3Sn surrounding grains of NbC and niobium. Two types of processing treatments have been examined resulting in desirable composite microstructures with good critical current and field values. Films of Nb_3Sn surrounding NbC grains were obtained by hot pressing powders of niobium, tin, and graphite. Films of Nb_3Sn surrounding niobium grains were obtained with presintered porous niobium impregnated with tin. Metallography, x-ray diffraction, and an electron-beam microprobe were used in the examination of the samples. The critical temperatures were measured and the field properties were determined using the pulsed field technique. The highest critical current (J_{c_N}) obtained was 53,700 A/cm². The highest critical temperature was 17.8°K, and the best upper critical field (H_{c_2}) was 234 kG. (auth)

5337 PRINCIPLE OF COMPENSATION OF DANGEROUS DIAGRAMS FOR BOSON SYSTEMS. I. MAXIMUM OVERLAP.

Kobe, Donald H. (Northeastern Univ., Boston). J. Math. Phys. (N. Y.), 9: 1779-94(Nov. 1968).

The principle of compensation of dangerous diagrams (PCDD), used by Bogolyubov to determine the coefficients in the canonical transformation to quasiparticles in boson systems, is obtained by maximizing the overlap between the true ground-state vector and the quasiparticle vacuum state. The zero-momentum state is treated exactly, which implies that the sum of all diagrams leading from the vacuum to a one quasiparticle state must be zero, in addition to the diagrams leading from the vacuum to the two quasiparticle state. Other criteria, such as the diagonalization of the quasiparticle reaction operator up to terms cubic in the operators, and the absence of one and two quasiparticle contributions to the true ground-state wave function, are also shown to lead to the PCDD. A generalization of the Hartree procedure of minimizing the ground-state energy is obtained by replacing the bare quasiparticle interaction with the quasiparticle reaction operator, and is shown to be equivalent to the PCDD. Finally, a perturbation expansion of the PCDD is obtained, and the reducibility of diagrams is discussed. (auth)

5338 PRINCIPLE OF COMPENSATION OF DANGEROUS DIAGRAMS FOR BOSON SYSTEMS. II. MINIMUM QUASIPARTICLE NUMBER. Kobe, Donald H. (Northeastern Univ., Boston). J. Math. Phys. (N. Y.), 9: 1795-1805(Nov. 1968).

The principle of compensation of dangerous diagrams (PCDD) postulated by Bogolyubov to determine the coefficients in his canonical transformation in boson systems is obtained from four criteria: (1) the number of quasiparticles in the true ground state is a minimum; (2) the "best" approximation to the true density matrix and pair amplitude is made; (3) the expectation value of an arbitrary operator is diagonalized up to terms cubic in the quasiparticle operators; (4) the most convenient starting point for dressing the quasiparticles is used. Quasiparticle Green's functions are introduced to obtain a diagrammatic expansion of the PCDD. The reducibility of the diagrams is also discussed.(auth)

5339 POSSIBILITY OF SUPERFLUIDITY IN SEMIMETALS DURING THE DIELECTRIC TRANSITION. Denisov, Yu. P.; Mnatsakanov, T. T. (Inst. of Theoretical Physics, Moscow). Sov. Phys.-Solid State (Eng. Transl.), 10: 1465-8(Dec. 1968).

Translated from Fiz. Tverd. Tela, 10: 1863-8(June 1968).

A semimetal with the same number of electrons and holes, whose ground state is unstable with respect to pairing of the electrons of one zone with the holes of another, is examined. Since the criterion of Landau, based on Galilean invariance, is not applicable to a crystal lattice, the following method of investigating the possibility of the appearance of superfluid phenomena in this system is proposed. Impurities are introduced in order to establish a system of coordinates. An alternating external field which acts the same on the holes and electrons is superimposed on the system. The relationship between momentum and the applied field, expressed in Fourier components, can be written in the form $j(k\omega_s) = k\varphi(k\omega_s)\, Q\,(k\omega_s)$. Obviously, the appearance in Q of terms proportional to $1/\omega_s$ for $\omega_s \to 0$, ω_s being the frequency of the external field, would indicate the presence of superfluid motion in the system. However, only terms proportional to ω_s arise in Q. This shows that superfluid motion does not exist in this system. (auth)

5340 JOSEPHSON EFFECT AND INFRARED DETECTION. Maurer, J. (Univ., Paris). Onde Elec., 48: 633-7(July-Aug. 1968). (In French).

A description is given of the Josephson effect which characterizes a junction between two superconductors separated by a very thin insulator (10Å). This effect consists of a continuous effect characterized by the passage of a current without any voltage input (it is possible to modulate this current by a magnetic field), and an alternating micro wave detector and transmitter effect. This last property makes it possible to consider measurements in the submillimeter range. The results are good in frequency measurement, only indicative in power measurement, but modulations can be followed up to 10^9 Hz. The utilization range does not extend beyond 10^{12} Hz. (IAA)

5341 ON THE STATIC SPIN SUSCEPTIBILITY OF SUPERCONDUCTORS WITH P-PAIRING AND COLLECTIVE EXCITATIONS. Garszynska, M. B. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 16: 663-8(1968).

The static spin susceptibility of superconductors with P pairing is obtained. The collective effects are taken into account for more general Hamiltonians than the ones considered previously. Bogolyubov's self-consistent field method is applied. (M.H.R.)

5342 EXPERIMENTS ON THE INTRINSIC LIMITATIONS OF DILUTION REFRIGERATION. Abel, W. R.; Wheatley, J. C. (Univ. of California, San Diego, La Jolla). Contract AT(11-1)-34. Phys. Lett., 27A: 599-600(Sept. 23, 1968).

By combining continuous dilution refrigeration, magnetic cooling, and single-cycle dilution refrigeration in a single device, a low magnetic temperature of 2 m°K and a limiting high temperature of about 4 m°K which is relatively insensitive to the ^{3}He extraction rate were obtained. At intermediate temperatures, increasing the ^{3}He extraction rate increases the warming rate. (auth)

5343 EFFECT OF ONE-BODY INTERACTIONS ON THE TRANSITION TEMPERATURE OF SUPERCONDUCTORS. Upadhyaya, U. N.; Sinha, K. P. (National Chemical Lab., Poona). Indian J. Pure Appl. Phys., 6: 546-9(Oct. 1968).

The effect of one-body spin-independent interactions, involving conduction and localized electron states taken in conjunction with phonon-induced attractive electron–electron interaction, is analyzed by the method of double time–temperature Green's functions. The resulting expression for the transition temperature (T_c) of a superconductor contains terms that indicate decrease in T_c emanating from the one-body interaction considered. (auth)

5344 THERMAL EXPANSION OF LIQUID HELIUM II. Harris-Lowe, R. F.; Smee, K. A. (Royal Military Coll., Kingston, Ont.). Phys. Lett., 28A: 246-7(Nov. 18, 1968).

The thermal expansion coefficient of liquid ^{4}He under the saturated vapor pressure and the density derivatives of the Landau parameters have been determined from new measurements of the dielectric constant at temperatures in the interval 0.85°K to 2.00°K. (auth)

5345 LOGARITHMIC CORRECTIONS TO THE THEORY OF THE λ TRANSITION IN ^{4}He. Wong, V. K. (Univ. of Michigan, Ann Arbor). Phys. Lett., 28A: 248-9(Nov. 18, 1968).

The logarithmic singularity in the specific heat is used to investigate the logarithmic corrections to the phenomenological theory of the λ transition in liquid helium-4. A justification of the theory of Mamaladze is also given. (auth)

5346 SUPERCONDUCTING ORDER PARAMETER IN THE TRANSITION REGION. Marcelja, S. (Univ. of Rochester, N. Y.). Phys. Lett., 28A: 180-1(Nov. 18, 1968).

The temperature dependence of the superconducting order parameter in the transition region is obtained by retaining in the Ginzburg–Landau theory the effects of higher-order interactions. Illustrative numerical results are exhibited for one- and two-dimensional systems. (auth)

5347 ROUNDING OF THE RESISTIVE TRANSITION IN METALLIC LEAD FILMS. Smith, R. O.; Serin, B.; Abrahams, E. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Lett., 28A: 224-5(Nov. 18, 1968).

The resistive transition of metallic lead films exhibit the rounding predicted by mean field theories of thermal fluctuations. Close to T_c, the data depend on current density; deviations from the predicted behavior as $T \to T_c$ are consistent with the expected breakdown of the theory. (auth)

5348 CRITICAL FIELD CURVES FOR SUPERCONDUCTORS WITH MAGNETIC IMPURITIES. Decker, Wayne Reeves. Contract W-7405-eng-82. Ames, Iowa, Iowa State Univ., 1968. 85p. (IS-T-221).

Thesis.

Critical field curves for thorium with a resistivity ratio of 1200 and three dilute gadolinium–thorium solid solutions have been measured by a ballistic induction technique from the critical temperature to 0.3°K. The alloys reported show characteristics of Type-I superconductors. The data for pure thorium are found to agree to within 0.3% with the theory of Bardeen, Cooper, and Schrieffer over the whole temperature range. Abrikosov Gor'kov critical field curves for superconductors with magnetic impurities are calculated as suggested by Skalski, Betbeder-Matibet, and Weiss. Measurements for the alloys agree with theory to within 0.5% over the entire temperature range. The specific heat jump at the critical temperature as calculated by the last authors is compared with values obtained from experimental data using Rutger's formula. (Disser. Abstr.)

5349 SUPERCONDUCTIVITY IN SEMICONDUCTORS. Deis, Daniel Wayne. Durham, N. C., Duke Univ., 1968. 130p.

Thesis.

The construction of an apparatus employing the techniques of adiabatic demagnetization capable of reaching temperatures in the millidegree region, and its use in the investigation of superconductivity in low carrier density materials (10^{20} to 10^{21} carriers per cm^3) are described. Measurements of the superconducting transition temperatures of both self and impurity-doped tin telluride were made down to lower temperatures and lower carrier densities than had previously been achieved. In self-doped tin telluride, superconductivity was found in six samples having carrier densities in the range 14.2×10^{20} to 5.06×10^{20} carriers per cm^3. In arsenic- and antimony-doped tin telluride, six sam-

ples having carrier densities between 10.9×10^{20} to 5.08×10^{20} carriers per cm^3 exhibited superconductivity. Transitions were also found in two samples of self-doped germanium telluride. Impurity-doped lead telluride and Bi_2Te_3 were investigated but superconductivity was not exhibited by either compound down to 0.0138 and 0.0188°K, respectively. The results of the experiment are compared with independent measurements made by J. K. Hulm and C. K. Jones of the Westinghouse Research Laboratories in Pittsburgh, Pennsylvania. An attempt is made to analyze the results in terms of the theory of Morel and Anderson. (Disser. Abstr.)

5350 PROPAGATION OF SOUND IN NARROW CHANNELS IN A ^{3}He–^{4}He SOLUTION. Karchava, T. A.; Sanikidze, D. G. (Inst. of Cybernetics, Tbilisi, USSR). Zh. Eksp. Teor. Fiz., 55: 1909-18(Nov. 1968). (In Russian).

The effect of dissipative processes due to the presence of walls on the propagation of waves in narrow channels filled with a superfluid ^{3}He–^{4}He solution is considered. Dispersion of waves moving in such channels is studied as a function of the ratio between the penetration depth of a viscous wave and the cross section of the channel. The propagation velocities and absorption coefficients of first, second and fourth sounds and the heat wave are calculated and their dependence on ^{3}He concentration is elucidated. Relations are obtained between the pressure, temperature, and concentration oscillation amplitudes in the various waves. All calculations are carried out for plane parallel and for cylindrical capillaries. (auth)

5351 STIMULATED MANDELSHTAM–BRILLOUIN SCATTERING IN He II. Tsintsadze, N. L. (Inst. of Physics, Tbilisi, USSR). Zh. Eksp. Teor. Fiz., 55: 1800-4(Nov. 1968). (In Russian).

Excitation of first and second sounds in He II by light waves is considered. Expressions are obtained for the increments and phase velocities of the sound waves. It is shown that in the presence of a light wave the sound wave velocities are smaller than when the light wave is absent in He II. In other words, focusing of sound waves by light waves occurs. (auth)

5352 SOME FEATURES OF THE VOLT–AMPERE CHARACTERISTICS OF JOSEPHSON TUNNEL JUNCTIONS. Yanson, I. K.; Albegova, I. Kh. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz., 55: 1578-88(Nov. 1968). (In Russian).

The dV/dI characteristics of Josephson tunnel junctions are investigated for Sn/Sn, In/In, and Sn with an In admixture. A complex dV/dI characteristic was observed for all contacts. This excludes anisotropy of the energy gap as an explanation of the phenomenon. The peculiarities observed are attributed to the complex structure of the transition layer between superconducting films consisting of a number of microcontacts. The dependence of the intensity of minima of the dV/dI characteristics on magnetic field strength confirm their relation to the Josephson effect. (auth)

5353 CRITICAL CURRENT DENSITIES IN SUPERCONDUCTING NIOBIUM FILMS SPUTTERED REACTIVELY IN THE PRESENCE OF NITROGEN GAS. Muto, Y.; Koto, N.; Fukuroi, T.; Saito, Y.; Anayama, T.; Mitsuoka, T.; Onodera, Y. (Tohoku Univ., Sendai). Appl. Phys. Lett., 15: 204-5(Sept. 15, 1968).

A critical current density of about 2×10^5 A/cm^2 in a transverse external field of 73 kOe, parallel to the film plane, was obtained at liquid-helium temperature for niobium films deposited on glass substrates by sputtering technique in an argon atmosphere with a dilute addition of nitrogen. This critical current density is larger than any other reported values for refractory metal carbides and nitrides with the NaCl structure. (auth)

5354 EXPERIMENTAL COMPARISON OF THE JOSEPHSON VOLTAGE–FREQUENCY RELATION IN DIFFERENT SUPERCONDUCTORS. Clarke, John (Univ. of California, Berkeley). Phys. Rev. Lett., 21: 1566-9(Dec. 2, 1968).

Using the ac Josephson effect it was demonstrated experimentally that 2e/h is identical in lead, tin, and indium to within 1 part in 10^8. (auth)

5355 PHASE INCOHERENCE IN THE dc SUPERCONDUCTING TRANSFORMER. Cladis, P. E. (Univ. of Rochester, N. Y.); Parks, R. D.; Daniels, J. M. Phys. Rev. Lett., 21: 1521–4 (Nov. 25, 1968).

A model is presented which explains the observed dependence of the coupling between the primary and secondary vortices on the driving current, or primary vortex velocity, in the dc superconducting transformer. The basic idea is that viscous drag effects lead to a slippage between the vortices in the primary film and those in the secondary film for sufficiently large vortex velocities. (auth)

5356 THEORY OF A JOSEPHSON OSCILLATOR. Stephen, Michael J. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev. Lett., 21: 1629-32(Dec. 9, 1968).

A quantum mechanical theory of superconducting tunnel junctions including noise is developed. The theory is applied to the calculation of the frequency pulling, linewidth of the radiation, and voltage power spectrum in the ac Josephson effect. (auth)

5357 EFFECTIVE RESISTIVITY OF A HARD SUPERCONDUCTOR DURING TRANSMISSION OF A MAGNETIC FIELD STEP. Gandolfo, D. A. (RCA Advanced Technology, Camden, N. J.); Dubeck, L. W.; Rothwarf, F. Contract NAS 8-11272. Solid State Commun., 6: 799-803(Nov. 1968).

It is known that for a type-II super conductor in the mixed state a changing magnetic field gives rise to an effective resistivity, ρ_{eff}, due to the motion of vortex lines. The effective resistivity produced in NbTi samples when subjected to a magnetic field step was studied, and it was found that ρ_{eff} has the following characteristics: (1) it is in the flux creep regime; (2) it increases with the size of the background magnetic field; (3) it increases with the size of the field step; and (4) it is smaller in a sample with stronger pinning. (auth) (UK)

5358 INVESTIGATION OF DISORDERED Sn FILMS BY SUPERCONDUCTING TUNNELING. Knorr, K.; Barth, N. (Univ., Frankfurt am Main). Solid State Commun., 6: 791-4(Nov. 1968).

Tunneling into superconducting Sn films with added Cu, Ag, and Au impurities was investigated. Values of 3.6 to 4.4 for $2\Delta/kT_c$ were obtained. The higher values are typical of the amorphous state of Sn, which is stable only at low temperatures. Annealing restores the crystal order, which in turn leads to lower values of $2\Delta/kT_c$. Comparison of the 2nd derivatives of the tunneling current of both amorphous and crystalline films reveals details which are related to the increased electron–phonon interaction in the amorphous phase of Sn. (auth) (UK)

5359 SUPERCONDUCTIVITY OF SOME SOLID SOLUTIONS BETWEEN COMPOUNDS OF A15 STRUCTURE ON VANADIUM BASE. Otto, G. (Univ., Giessen, Ger.). Z. Phys., 218: 52-5(1969). (In German).

Ternary intermetallic compounds on the base of V_3Ga and V_3Si have been prepared by arc melting, substituting gallium and silicon partly by aluminium, gallium, indium, silicon, and germanium. In a similar way, part of the niobium in the compounds Nb_3Al and Nb_3Ga has been replaced by vanadium. All these ternary compounds have been investigated for superconductivity. Only by substituting gallium in V_3Ga partly by aluminium or silicon, could the transition temperature be raised. (auth)

5360 PHENOMENOLOGY OF SUPERFLUIDS AND SUPERCONDUCTORS. de Gennes, P.-G. (Service de Physique de Solides, Orsay, France). pp 149-217 of Probleme a N Corps. De Witt, Cecile; Balian, Roger (eds.). New York, Gordon and Breach Science Publishers, Inc., 1968. (In French).

The subject is discussed under the following major headings: (1) superfluidity (experimental facts); (2) effects of Bose statistics; (3) Josephson effect (qualitative description); (4) hydrodynamics of ^{4}He at T = 0; (5) macroscopic quantum effects in superconductors; (6) Ginsburg–Landau equations; (7) differences between number of condensed bosons (n_0) and superfluid density (ρ_s) in the case of He; (8) one-dimensional superconductors; and (9) excitations in superconductors. (TSS)

5361 ELEMENTS OF THE THEORY OF STRONG-COUPLING SUPERCONDUCTORS. Ambegaokar, Vinay (Cornell Univ., Ithaca, N. Y.). pp 299-350 of Probleme a N Corps. De Witt, Cecile; Balian, Roger (eds.). New York, Gordon and Breach Science Publishers, Inc., 1968.

Theoretical discussions are given for the following: (1) the model, (2) methods of solution, (3) the effective interactions, (4) the normal system: quasi particles vs. strong coupling, (5) the onset of superconductivity, (6) the gap equations, (7) experimental tests of the gap equations; tunneling, (8) some thermodynamic and transport properties, and (9) spatially varying phenomena; nucleation. (M.O.W.)

5362 GREEN'S FUNCTIONS AND SUPERFLUIDS. Kadanoff, L. P. (Univ. of Illinois, Urbana). pp 105-78 of Statistical Physics, Phase Transitions, and Superfluidity. Vol. I. Chretien, M.; Gross, E. P.; Deser, S. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

The following topics are discussed: (1) introduction to Green's function technology, (2) the case of free particles, (3) simplified microscopics of the superfluid, (4) the theory of superconductivity, (5) the Hartree and Hartree–Fock approximations, (6) Green's function technology, (7) electrons in metals, and (8) Green's function for the superconductor. (M.O.W.)

5363 PHASE TRANSITIONS. Brout, R. H. (Univ. Libre, Brussels). pp 1-103 of Statistical Physics, Phase Transitions, and Superfluidity. Vol. 1. Chretien, M.; Gross, E. P.; Deser, S. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

The following topics are discussed: (1) ferromagnetism, or spin phenomena, in three models, (2) liquid-vapor condensation, (3) freezing, (4) superconductivity, and (5) ferroelectricity. (M.O.W.)

5364 STATISTICAL PHYSICS, PHASE TRANSITIONS, AND SUPERFLUIDITY. VOLUME I. Chretien, M.; Gross, E. P.; Deser, S. (eds.). Brandeis University Summer Institute in Theoretical Physics, 1966. New York, Gordon and Breach, Science Publishers, 1968. 335p.

Separate abstracts are included for the five individual chapters. (M.O.W.)

For abstracts of individual chapters see: 5362, 5363, 5365, 5366, and 5510.

5365 SOUND VELOCITY IN ^{4}He NEAR THE CRITICAL POINT. Chase, C. E. (Massachusetts Inst. of Tech., Cambridge, N. J.). pp 307-25 of Statistical Physics, Phase Transitions, and Superfluidity. Vol. I. Chretien, M.; Gross, E. P.; Deser, S. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

Diagrams are given for the sound velocity in helium-4 near the critical point as functions of pressure and temperature. (M.O.W.)

5366 MATHEMATICAL MECHANISMS OF PHASE TRANSITIONS. Kac, Mark (Rockefeller Univ., New York). pp 241-305 of Statistical Physics, Phase Transitions, and Superfluidity. Vol. I. Chretien, M.; Gross, E. P.; Deser, S. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

Various models for phase transitions are described. (M.O.W.)

Plasma and Thermonuclear Physics

5367 (NP-17683) BIBLIOGRAPHY ON THE HIGH TEMPERATURE CHEMISTRY AND PHYSICS OF GASES AND PLASMAS. No. 28. Brewer, L. (comp.) (California Univ., Berkeley. International Union of Pure and Applied Chemistry. Commission on High Temperatures and Refractories). Sept. 30, 1968. 26p.

A listing of 114 papers on spectroscopy of interest to high temperature chemistry is presented. In addition, 126 papers on reactions between gases and condensed phases are included. (M.O.W.)

Confinement and Heating

Refer also to abstract 5161.

5368 (AEC-tr-7002) INVESTIGATION OF ELECTROMAGNETIC TRAP. Lavrent'ev, O. A. Translated from pp 77-147 of Magnitnye Lovushki, Vypusk 3, Naukova Dumka, Kiev, 1968. 82p. Dep. CFSTI.

A machine translation of a review of methods employing electromagnetic traps for confining hot plasma is presented. 80 references. (M.O.W.)

5369 (GA-8526) CONTROLLED THERMONUCLEAR RESEARCH PROGRAM. Summary Progress Report, July 1-December 31, 1967. Miller, P. H. Jr.; Ohkawa, T. (Gulf General Atomic, Inc., San Diego, Calif.). Feb. 15, 1968. Contract AT(04-3)-167. 17p. Dep. CFSTI.

A brief report on the conversion of the octupole device to a quadrupole configuration is given. Abstracts for papers presented at the 1967 annual meeting of the American Physical Society, Division of Plasma Physics, are given. (M.O.W.)

5370 (ORO-2454-11) THE HELIOS RESEARCH PROGRAM. Plasma Physics Bulletin, Vol. 8, No. 3. Robertson, Harry S. (Miami Univ., Coral Gables, Fla. Dept. of Physics). Oct. 1968. Contract AT(40-1)-2454. 111p. (MIAPH-PL-68.7). Dep. CFSTI.

A comprehensive experimental and theoretical program is proposed, exploring a combination of new and standard techniques for containing and heating steady-state plasmas in open-ended geometry. The principal vehicle proposed for this research is the Helios (for Heated Lithium Ion System) facility, in which a contact-ionized lithium plasma is to be heated by a stochastic electric field and contained in a minimum-B, boundary-stabilized cage. All possible free-energy sources are to be eliminated, for improved stabilization, and suppression of instability growth is further expected as a side benefit of the stochastic heating process. Experiments are proposed to test, among other things, the value of the stochastic field in suppressing instabilities and in heating the plasma uniformly, the conjecture that stable, steady-state confinement requires ambipolarity, and further effects of the boundary conditions on heating, containment, and stability. The entire program is intended to be a vigorous exploration of the problem of plasmas in open-ended systems. Helios is therefore designed to be an extremely flexible and versatile facility, though of modest size, and is intended to be a means of evaluating its own design features and applying them to plasmas in general, rather than an end in itself. A number of related and supporting investigations are proposed as part of the overall program. Several of these are experiments that make no direct use of the Helios facility, but are in most cases continuation of existing programs. (auth)

5371 Z-Θ DISCHARGE ARRANGEMENT WITH SUPERIMPOSED STATIONARY MAGNETIC FIELD ON A SUPERCONDUCTING COIL. Hertz, W. (Siemens-Aktiengesellschaft, Erlangen, Ger.). Z. Naturforsch., 23a: 1373-82(Sept. 1968). (In German).

The combination of a strong stationary magnetic field of a superconducting coil with high-temperature plasma and the time variation of this field represent an important expansion of plasma physics experimental possibilities and an increase of the applicability of superconducting coils in plasma physics. The report is concerned with a Θ-discharge apparatus in which the discharge takes place in the superimposed stationary field of a superconducting coil. A Z discharge is used for plasma excitation. The problem of the shielding of the electromagnetic field of the superconducting coil was treated experimentally and theoretically. The operational capacity of the research installation was shown by means of some streak photographs. (tr-auth)

5372 TOWARDS THERMONUCLEAR FUSION. Romanovskii, Michail (Kurchatov Inst. of Atomic Energy, Moscow). Sci. J., 4: No. 11, 43-8(Nov. 1968).

In their attempts to harness the energy of thermonuclear fusion to supply power, Soviet physicists claim to have produced the densest and hottest man-made plasma. They are also developing unconventional ways of containing it. A brief description of this Soviet work is given. (auth) (UK)

5373 USING ELECTRONS TO ACCELERATE AND CONFINE IONS. Consoli, Terenzio. Euratom Rev., 7: 87-92(Sept. 1968).

A brief discussion of the basic principles of thermonuclear derives employing relativistic electron beams for confining plasma is given. (M.O.W.)

5374 ON THE THEORY OF THE STOCHASTIC HEATING OF PARTICLES CONTAINED IN MAGNETIC MIRROR SYSTEMS. Krlin, L. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 18: 1467-70(1968).

A study was made of the action of a high-frequency stochastic field on particles contained in a magnetic mirror system. The following was assumed in this study: the rf field is excited by an external source, and penetrates from one side of the mirror to only those locations in which the rf field and the cyclotron frequency are at resonance. Further, the specified rf field has a known correlation, and remains unaffected by a change in the particle distribution function produced by heating. (auth)

5375 INVARIANTS IN THE MOTION OF A CHARGED PARTICLE IN A SPATIALLY MODULATED MAGNETIC FIELD. Dunnett, D. A. (Univ. of Liverpool); Laing, E. W.; Taylor, J. B. J. Math. Phys. (N. Y.), 9: 1819-23(Nov. 1968).

The effect of a spatial modulation in the magnetic field on invariants such as the magnetic moment $\mu = V_\perp^2/B$ is studied. In particular, the question of whether an invariant still exists when the wavelength of the modulation is comparable to the gyro radius of the particle is investigated. In an axially symmetric magnetic field, with a square-wave modulation, the orbit equations reduce to algebraic relations convenient for numerical study. We find from such studies that orbits are of two types: (a) regular orbits which generate an invariant; (b) orbits which are quasi-ergodic. An invariant is also calculated by perturbation theory with the depth of modulation of the field as a small parameter. For this a modified form of perturbation theory which overcomes the difficulty of infinities arising at resonance between the perturbation and the cyclotron period is developed. This difficulty in fact corresponds to a change in topology of the invariant curves. The invariant calculated from this theory shows very good agreement with the numerically computed orbits of type (a). The transition to quasi-ergodic behavior cannot be predicted analytically, but some indication of it may exist in the complex topology of the invariant curves in the ergodic regions. (auth)

5376 IMPORTANCE OF SYMMETRY IN HELICAL MAGNETIC FIELDS. Maksimov, G. P.; Cheremnykh, P. A. Zh. Tekh. Fiz., 38: 1472-4(Sept. 1968). (In Russian).

The importance of considering the symmetry of a helical magnetic field is discussed for two cases: (1) in studies of magnetic surfaces by electron beams, and (2) during capture of charged particles in magnetic traps with helical type fields. (tr-auth)

5377 BREAKDOWN OF MAGNETIC SURFACES IN THE S-1 STELLARATOR. Karmanov, F. V.; Cheremnykh, P. A. Zh. Tekh. Fiz., 38: 1475-6(Sept. 1968). (In Russian).

Studies carried out by electron beam methods revealed significant deformations of the magnetic surface of the S-1 stellarator. The deformations appear in the shape of emissions leading from the separatrix to the wall of the vacuum chamber. With the increase of h_3/H_0 the deformation increased. (tr-auth)

5378 MAGNITNYE LOVUSHKI. VYPUSK 3. (Magnetic Traps. Third Edition). Sinel'nikov, K. D. (ed.). Respublikanskii Mezhvedomstvennyi Sbornik. Kiev, Naukova Dumka, 1968. 236p.

Twenty articles are included on experimental and theoretical studies carried out during 1964–1965 and on the data presented at the Sixth Conference on plasma physics held Sept. 27–Oct. 4, 1965 at the Inst. of Physics and Technology of the Academy of Sciences, Ukrainian SSR. The data cover the theoretical and experimental studies of charged-particle injection and motion in various types of traps (with magnetic mirrors, combined magnetic and electric fields, and constant and pulsed magnetic fields). Vacuum problems and techniques for producing strong magnetic fields are also discussed. (R.V.J.)

Diagnostics

Refer also to abstracts 4860 and 5131.

5379 (IPP-2/66) SPECTROSCOPIC MEASUREMENTS OF ABSOLUTE DENSITY DISTRIBUTION OF THE ATOMIC BEAM OF A Q-DEVICE. Hashmi, M.; van der Houven van Oordt, A. J. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Mar. 1968. 13p. Dep.

The absolute density distribution of a finely collimated atomic beam of barium is measured by resonance-fluorescence scattering of light. (auth)

5380 METHOD AND DEVICE FOR STRIKING AN ELECTRIC ARC AND GENERATING VERY SHORT HIGH-VOLTAGE PULSES. Langer, P. (to Commissariat a l'Energie Atomique). Canadian Patent 790,130. July 16, 1968. Priority date Sept. 16, 1965, France.

For photography of plasma bursts having a very short lifetime, a method is described for generating electrical pulses of 10 to 20 kV of less than 20 nanoseconds and with leading-edge or rise times of 0.5 nsec. The equipment consists of a laser and a vacuum enclosure containing the spark gap, with one of the walls of the enclosure being constituted by a photocathode located in the path of the laser beam. The laser beam generates an electron beam which is focused between the spark-gap electrodes. A thin semi-reflecting plate is interposed between the laser and the cathode and so oriented that the photocathode receives only that portion of the light from the laser beam which is reflected by the plate. (F.S.A.)

5381 BEHAVIOR OF THE CHARGED PARTICLES ACROSS A SHOCK WAVE IN A PARTIALLY IONIZED GAS. Kamimoto, Goro; Nishida, Michio; Yoshida, Kazuakira. Nippon Koku Gakkaishi, 16: 35-46(Feb. 1968). (In Japanese).

Measurements were made by means of the Langmuir-probe technique at Mach numbers of 4.17, 4.39, and 4.88, of the electron temperature and the ion density across a normal shock wave in nonequilibrium, weakly ionized argon. The electron-temperature distribution is calculated, using the Navier–Stokes equation. It was found that the existence of a broad thermal layer at high electron temperatures was determined by the Mach number and the degree of nonequilibrium. Considering the decay of the free-stream ion density, the ion density distribution across the shock is calculated, using the Mott–Smith solution for a neutral shock. It is shown that the ion density decrease, due to chemical reaction, diffusion, etc., in the free stream, has a great influence on the free-stream ion density. (IAA)

5382 ELECTRON DENSITY MEASUREMENTS OF PLASMA JET BY MICROWAVE INTERFEROMETRY. Kamimoto, Goro; Kimura, Takeyoshi; Nishida, Michio; Horiuchi, Nozomu. Nippon Koku Gakkaishi, 16: 67-74(Mar. 1968). (In Japanese).

Measurements were made with a microwave interferometer of the electron density in argon and nitrogen plasma jet flows. The obtained electron number density in the center of the flow was in the range from 10^{12} to 10^{13} liters/cm^3 for argon and from 10^{11} to 10^{12} liters/cm^3 for nitrogen. The former agreed with the results of Langmuir-probe measurements. The phase shift $\Delta\phi$ of the microwave through the plasma, due to the existence of a transient plasma, was obtained from direct measurements of the microwave power passed through each arm of the interferometer, as well as from measurements of the interferometer output. (IAA)

5383 EFFECT OF STRONG INCREASE OF ABSORPTIVITY OF A PARTLY IONIZED GAS AT HIGH LIGHT INTENSITIES. Generalov, N. A.; Kozlov, G. I.; Raizer, Yu. P. (Inst. of Mechanics Problems, Moscow). JETP Lett. (USSR) (Engl. Transl.), 8: 82-4(Aug. 5, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 138-41(Aug. 5, 1968).

A nonlinear effect of strong increase of absorption of light in plasma with increasing light intensity was observed. A homogeneous plasma with stable parameters was produced in a shock tube. A Q-switched ruby laser producing stable 20-MW pulses of 50-nsec duration was used. The experiments were performed in xenon. (M.H.R.)

5384 MEASUREMENT OF THE DENSITY GRADIENT OF A PLASMA COLUMN. Tulle, Pierre A.; Zanfagna, Bruno (EURATOM-CEA, Fontenay-aux-Roses, France). Compt. Rend., Ser. A and B, 267: 609-11(Sept. 23, 1968). (In French).

The method described depends on the radial displacement as a function of the frequency of the layer on which an electromagnetic wave polarized by the extraordinary mode is reflected. The propagation and electric field are perpendicular to the external magnetic field. (tr-auth)

5385 CONTRIBUTION TO THE STUDY OF VERY DENSE PLASMAS. Nguyen Van Trong (Compagnie Internationale pour l'Informatique, Yvelines, France). Compt. Rend., Ser. A and B, 267: 612-15(Sept. 23, 1968). (In French).

Very dense plasmas produced by explosion of wires and mercury filaments were studied. Electronic densities higher than 10^{18} electrons/cm^3 were obtained in fast condensed discharges (F ~ 100 kHz) at average energy (500 joules). The results of measurements obtained by different methods are compared. (tr-auth)

5386 MEASUREMENTS OF CHARGED PARTICLE DENSITY IN MOVING PLASMA CLOUD. Golubchikov, L. G. Zh. Tekh. Fiz., 38: 1477-81(Sept. 1968). (In Russian).

Concentrations of charged particles in a moving plasma cloud were studied in pulsed strong-current discharges in a metal-wall chamber. The discharge was in deuterium gas under pressure from 0.4 to 1.5 mm Hg. Graphs were constructed as functions of time, charged-particle density, and the velocity of the current envelope. It is shown that at the moment of strong shock-wave buildup and four-dimensional compression, the ionization reached 100%. (R.V.J.)

5387 HOLOGRAPHIC PLASMA DIAGNOSTICS (REVIEW). Zaidel, A. N.; Ostrovskaya, G. V.; Ostrovskii, Yu. I. (Leningrad Inst. of Physics and Tech.). Zh. Tekh. Fiz., 38: 1405-19(Sept. 1968). (In Russian).

A brief review is given on uses and development of holographic methods in studies of plasma diagnostics carried out during 1966–1967. Various aspects of phase variations, resolving time, θ-pinch, pulse tubes, laser sparks, and steady-state plasma are discussed. 36 references. (R.V.J.)

5388 TIME-RESOLVED MEASUREMENTS OF ELECTRON NUMBER DENSITY AND ELECTRON TEMPERATURE USING LASER INTERFEROMETRY AT 337-μm WAVELENGTH. Parkinson, G. J. (Imperial Coll. of Science and Tech., London); Dangor, A. E.; Chamberlain, J. Appl. Phys. Lett., 13: 233-5(Oct. 1, 1968).

An experiment is described where a cw HCN laser working primarily at 337-μm wavelength was used as the source of a Mach–Zehnder interferometer for the study of plasma decay in the electron number density region $5 \times 10^{15} > n_e > 5 \times 10^{13}$ cm^{-3}. It was found that an estimate of the electron temperature in the range 10^3 to $10^{4\circ}$K could also be made from the amplitude of the interferometer fringes. (auth)

5389 MICROWAVE REFLECTION MEASUREMENTS OF ELECTRON DENSITIES IN ELECTROMAGNETICALLY DRIVEN SHOCK-PRODUCED PLASMAS. Funahashi, Akimasa; Takeda, Susumu (Nagoya Univ., Japan). Mem. Fac. Eng., Nagoya Univ., 19: 250-69(Nov. 1967).

Conformity between experimental values of plasma densities and theoretical data calculated from the Rankine–Hugoniot and Saha equations are discussed. The electron densities from 10^{13} to 10^{17} cm^{-3} in plasmas produced by electromagnetically driven, propagating, or reflecting shock waves are measured by a microwave reflection method. The Mach number of the shock waves is varied from 9 to 25 in gases at pressures from 0.4 to 2.0-mm Hg. The gases used are argon, air, helium, and nitrogen. A 35-GHz microwave reflection probe is inserted into a T-type shock tube perpendicularly to its axis, or is placed at the tube and parallel with the axis. Even though some perturbation of the gas flow by the inserted probe is expected, surprisingly good agreement is found between the microwave and spectroscopic measurements. The measured electron densities are compared with theoretically predicted

values which are calculated from the Rankine–Hugoniot and Saha equations. For Mach numbers higher than 20, the maximum values of the electron densities measured behind the shock fronts agree very well with the theoretically predicted values. For low Mach numbers, however, the measured maximum electron densities are lower than the theoretically predicted values. An explanation of this phenomenon is suggested. (IAA)

5390 DETERMINATION OF THE PLASMA ELECTRON DISTRIBUTION FUNCTION ON BASIS OF THE BREMSSTRAHLUNG RADIATION SPECTRUM. Tikhonov, A. N.; Alikaev, V. V.; Arsenin, V. Ya.; Dumova, A. A. (Inst. of Applied Mathematics, Moscow). Zh. Eksp. Teor. Fiz., 55: 1903-8(Nov. 1968). (In Russian).

A stable method for obtaining the approximate solutions of integral equations of the first kind (regularization technique) is employed for analyzing the bremsstrahlung spectrum produced by electrons of a plasma heated by electron-cyclotron resonance in an adiabatic trap. The electron energy distribution function $f(\epsilon)$ is determined in this manner (under the assumption that it is isotropic). At energies $\epsilon \approx$ (80 to 85) keV a pronounced second local maximum is observed ("double-temperature" plasma). (auth)

5391 THEORY OF THE CYLINDRICAL LANGMUIR PROBE IN A FLOWING COLLISIONLESS PLASMA. McDonald, Peter Wendell. Raleigh, N. C., North Carolina State Univ., 1968. 74p.

Thesis.

An exact method is developed to obtain theoretical predictions of the current collected by a cylindrical Langmuir probe in a moving collisionless plasma. The functional relation between the ion current and plasma velocity is determined for probe potentials ($e\phi_p/kT_+$) of 2, 5, 10, and 25 with ratios of probe radius-to-ion Debye length ($r_p/\lambda D_+$) of 1.0, 0.3, and 0.1. Results were obtained for speed ratios $[U/(2kT_+/m_+)^{1/2}]$ of zero to 3 using an ion-to-electron temperature ratio (T_+/T_-) of 1. The method is not restricted to a particular range of the four parameters; however, the results that are presented were limited by the availability of computer time. The computations were carried out on an IBM 360/75. The infinite plasma is represented by a boundary at a finite radius outside the sheath of the probe. Although any velocity distribution may be assumed at this boundary, only monoenergetic solutions have been computed thus far. The ion density distribution and current are determined from thousands of ion trajectories in an iterative scheme along with the potential distributions in the sheath. Comparison with previous work (for a plasma at rest) indicates that the monoenergetic solutions obtained herein closely resemble those which would be obtained by assuming a Maxwellian distribution. The results obtained for a moving plasma verify the symmetric field approximation (that the asymmetry of the electric potential has only a minor effect on current collection when the sheath thickness is sufficiently large). Computed ion density and potential distributions are presented graphically for the case of the still plasma. An approximate description of the asymmetry accompanying a moving plasma is given in the form of contours of constant potential and ion density. (Diss. Abstr.)

5392 RADAR INTERFEROMETRY MEASUREMENTS OF THE PROPERTIES OF A TURBULENT PLASMA. Weissman, David Everett. Stanford, Calif., Stanford Univ., 1968. 65p.

Thesis.

A diagnostic technique was developed for the measurement of the spatial size of a bounded turbulent plasma. This involved an electromagnetic scattering technique which could measure the spatial distribution of the scattering cross section per unit volume of an inhomogeneous turbulent plasma. The size information is contained in the spatial distribution of the parameters that affect the cross section per unit volume. The parameters are also measured independently using probes. The desirable features of the technique studied were that it could be performed from a remote location outside the region of interest and, because the interaction with the dielectric material was electromagnetic, it did not perturb the parameters of the plasma. This study centered about a laboratory-produced turbulent plasma column from which microwave electromagnetic energy in the form of essentially a plane monochromatic wave was backscattered. The instrument of primary interest is an interferometer that forms the correlation of the randomly varying envelope and phase functions of the incoherent backscattered fields at two separated receiving points. It is shown how this measured correlation contains information about the radial profile of the parameters of the turbulent flame that determine the radar cross section per unit volume. These parameters are the mean square of the fluctuating component of the electron density and the average size of the turbulent eddies. The functional relation between the electromagnetic field correlation and the distance separating the receiving points, along a direction transverse to the column axis, was measured. This measured function was compared with a predicted function that was based on comprehensive probe measurements of the turbulence and flame parameters and the assumption that the total electric field in the plasma was the incident field. In this way the accuracy of the interferometer technique could be tested. This method of approach was found to be successful. The relative performance of several interferometer techniques was also considered in detail. By proving the technique in this way it is hoped that it will find application to problems where the averaged parameters of a remote turbulent dielectric, that are measurable, are useful information. (Diss. Abstr.)

5393 NEW SPECTROSCOPIC METHOD OF HIGH-PRESSURE ARC DIAGNOSTICS. Jen, Teh-sen. Pittsburgh, Carnegie-Mellon Univ., 1968. 109p.

Thesis.

General properties of the resonant-line spectral profile emitted by high-pressure arcs are investigated. The shape of the strongly broadened and greatly reversed profile is studied using the computed D-line profiles from sodium dc arcs as the studying samples, and the relationship to the key plasma parameters is established. It is found that the relative intensities at the lateral peaks of the resonant profile are proportional to the corresponding intensities in the Planck spectrum for an "effective central temperature" T_e. This T_e is uniquely related to the actual central temperature with only slight dependence upon the shape of the temperature profile. It is also found that the average optical depth at the lateral peaks from the arc edge to its center is unity and this leads to a relationship between the separation of the lateral peaks and the vapor pressure. Other important properties have also been obtained. These properties generate methods to obtain accurate values of the plasma parameters when a set of good experimental spectral profiles is given. With only the spectral profile for the radiation along the diameter of the arc, these methods can estimate readily the central temperature with ±100°K of its true value and the pressure with a maximum error of 20%. These results obtained for dc arcs are then extended to the case of ac arcs and applied to published experimental spectral profiles of high-pressure sodium arcs and potassium ones. The plasma parameters obtained in this way are in good agreement with the results obtained otherwise. In addition to these, the electric and thermal conductivities of sodium high-pressure arcs are calculated and the temperature profiles are then obtained theoretically to give another justification of the diagnostic methods presented. (Diss. Abstr.)

5394 SVERKHVYSOKOCHASTOTNYE METODY ISSLEDOVANIYA PLAZMY. (The Ultra-High-Frequency Methods of Investigation of Plasma). Golant, V. E. (ed.) Moscow, Izdatel'stvo Nauka, 1968. 328p.

A systematic description is given of methods of experimental investigation of plasma, based on the interaction of uhf electromagnetic waves with plasma. The uhf methods permit one to obtain diverse information concerning concentrations, the average electron energy, and the frequency of their collisions with heavy particles. Main attention is devoted to the theoretical basis of the described methods. The first part of the book is concerned with the methods of uhf sounding of plasma. The theory of interaction of electromagnetic waves with plasma is briefly discussed. The different methods of sounding of plasma, the methods of free space, resonators, waveguide methods, and also contact methods (uhf probes) are discussed. The second part is devoted to the detection of uhf radiation from plasma. The theory of thermal radiations from plasma and the methods of experimental investigation are described. (tr-auth)

5395 ELECTRON WAVES AND RESONANCES IN BOUNDED PLASMAS. Vandenplas, Paul E. New York, John Wiley and Sons, Inc., 1968. 234p. $11.50.

This book on plasma physics considers the joint experimental and theoretical work on electron waves in bounded plasma. The treatment is restricted to cases for which the Poynting vector of the incoming electromagnetic field is perpendicular to the axis of the system. The chapter headings are: general theoretical methods and experimental techniques, the uniform plasma slab–condenser system, the hollow cylindrical plasma, scattering of a plane electromagnetic wave by a plasma column in steady magnetic fields (cold plasma approximation), hot non-uniform plasma column, metallic and dielectric resonance probes, plasma–dielectric coated antenna, general considerations, and volume theorems useful in stating mathematical boundary conditions. A bibliography of 221 references is included. (D.L.C.)

5396 HYDROGEN IONS IN THE POSITIVE COLUMN OF A HYDROGEN GLOW DISCHARGE. Yamane, Mikiya (Central Research Lab., Tokyo). J. Chem. Phys., 49: 4624-32(Nov. 15, 1968).

A mass-spectrometric technique has been applied to the investigation of the positive column of a hydrogen glow discharge. Ions emerging out of the tube are found to be composed of major

components of H^+ and H_3^+ ions and minor components of H_2^+ ion over a range of E/p (the ratio of electric field strength to pressure) from about 30 to 100 V/cm · mm Hg and in a pressure range from 0.2 to 1.6 mm Hg. The relative density of H^+ ions decreases monotonically with increasing pressure from 57% at p = 0.2 mm Hg (E/p ≅ 100) to 36% at p = 1.6 mm Hg (E/p ≅ 30), while that of H_3^+ ions increases from 38% at p = 0.2 mm Hg (E/p ≅ 100) to 62% at p = 1.6 mm Hg (E/p ≅ 30). The H_2^+ ion density decreases with increasing pressure or with decreasing E/p and is less than 10% of the total ion over the pressure range investigated. It is then found possible to obtain collision frequencies of the reactions $H_2^+ + H_2 \rightarrow H_3^+ + H$ and $H_3^+ + H_2 \rightarrow H^+ + H + H_2$ as a function of E/p, assuming that these collision processes predominate in the plasma. (auth)

Kinetics

Refer also to abstracts 5122, 5173, 5269, and 5314.

5397 (JPRS-42891) PRODUCTION OF AN INVERSE POPULATION BY MIXING OF A HOT PLASMA WITH A COLD GAS. Popov, L. V. Translated from Zh. Prikl. Spektrosk, 5: 188-94(Aug. 1966). 10p. (TT-67-33517). CFSTI.

An analysis was made of a model in which the interaction of a hot plasma and a cold gas is used to create an inverse population. The impossibility of producing an inversion with high electron concentrations ($n_1 = 10^{16}$ cm^{-3}) is proven with hydrogen as an example, and conditions are presented under which the inversion can be realized. (auth)

5398 (LA-tr-68-51) MEASUREMENT OF THE THERMAL CONDUCTIVITY OF HYDROGEN BETWEEN 2000 AND 7000°K. Behringer, K.; Kollmar, W.; Mentel, J. Translated for Los Alamos Scientific Lab., N. Mex., from Z. Phys., 215: 127-51 (1968). 32p. Dep. CFSTI.

Experimental and theoretical investigations have been performed to determine the thermal conductivity of hydrogen in the temperature range between 2000 and 7000°K. For this purpose, the radial temperature distributions for various currents and the E-I-characteristic of a low-current wall-stabilized hydrogen arc have been measured. In the dark region of the arc outside the bright core, the temperature and the thermal conductivity between 2000 and 4500°K were found by means of the schlieren technique. The electron temperature in the core of the arc results from spectroscopic measurements. The gas temperature has been calculated with a formula derived from the kinetic theory of gases. Assuming a constant collision integral Q_{eH}^{11}, the radial distribution of electric conductivity has been calculated according to Langevin's formula. The value $Q_{eH}^{11} = 30 \times 10^{-16}$ cm^2 results by comparing the integrated conductance with the measured one. Since now the radial distribution of power input and the temperatures are known, the thermal conductivity between 4500 and 7000°K can be determined as well. The total course of the heat conductivity shows a strong peak at the temperature of 3740°K characteristic for the dissociation process. (auth)

5399 (SC-T-68-1520) ON THE NATURE OF THE SO-CALLED NORMAL CATHODE FALL IN GLOW DISCHARGES. Rothhardt, Ludwig. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Proc. Int. Conf. Ioniz. Phenomena Gases, 5th, Munich, 1961, 290-6(1962). 16p. (CONF-610803-1). Dep. CFSTI.

It is not yet understood what causes a glow discharge to show normal properties. Therefore, experiments were made with discharge tubes, which allowed one to compensate the edges of the cathode region. Thus it becomes apparent that the existence of such an edge and the occurrence of normal features are correlated. Preliminary theoretical discussion shows that the existence of an edge causes additional losses so that the edge region is burning in a stationary manner only with a higher (i.e., normal) voltage than the minimal voltage of edgeless discharges. In order to be stable, the whole discharge is forced to burn with that normal voltage. (auth)

5400 (SU-IPR-259) STUDIES OF PLASMA OSCILLATIONS. Status Report No. 32, February 1–July 31, 1968. (Stanford Univ., Calif. Inst. for Plasma Research). Sept. 1968. Contract AT(04-3)-326. 45p. Dep. CFSTI.

The research is primarily directed toward the investigation of plasma wave propagation and instabilities in discharges at pressures of the order of 1 mtorr. Although a comprehensive study of this nature will lead to a general understanding of the types of instabilities present in low-pressure discharges, and of how perturbations propagate through the plasma, the main interest is in instabilities which are similar to those occurring in thermonuclear-fusion study devices. Current activities include the following topics: (a) Low-frequency ion–acoustic and drift waves on the positive column in a magnetic field. An rf perturbation theory based on a self-consistent solution for the steady-state column has been derived, and is being tested experimentally. (b) Electron cyclotron echoes. The response of a magnetoplasma to short pulses at the cyclotron frequency is being studied. The detailed physical description of the phenomena involved permits the development of techniques for plasma density measurement and determination of collision data. (c) Beam/plasma interaction. The aspect of this phenomenon currently being studied is that of beam/surface wave interactions in bounded geometry. (d) Wave/wave interactions. The basic equations of small-signal plasma wave theory may now be considered to have been well verified experimentally, and higher-order approximations can be attempted. The work in this direction concerns the nonlinear coupling of cyclotron harmonic waves. (auth)

5401 CONTRIBUTIONS TO THE KINETIC THEORY OF WEAKLY IONIZED PLASMAS IN AN EXTERNAL CONSTANT ELECTRIC FIELD. Stenflo, Lennart. Abstracts of Uppsala Dissertations in Science. Uppsala, Uppsala Univ., 1968. 10p. Thesis

A summary is made of 9 published papers by the author on the following: oscillations of a weakly ionized plasma in a constant electric field; plasma oscillations in a constant electric field; whistler-mode propagation in the presence of a longitudinal electrostatic field; runaway in weakly ionized plasmas; conductivity of a plasma media in external electric fields; time-dependent phenomena for a weakly ionized plasma in an external electric field; negative absorption due to collisions in a drifted electron plasma; high-field distribution function in GaAs; and high-field electron distribution function in GaAs. (Sweden)

5402 MICROSCOPIC APPROACH TO KINETIC THEORY: INHOMOGENEOUS SYSTEMS. Chappell, Willard R. (Univ. of Colorado, Boulder). J. Math. Phys. (N. Y.), 9: 1921-6(Nov. 1968).

The microscopic linearized Vlasov equation is solved in terms of a generalized inverse dielectric function $\epsilon^{-1}(r,r';t,t')$ and the initial phase-space density fluctuation. This expression is then used to calculate the density autocorrelation function and to obtain a generalized kinetic equation for plasmas and gravitational gases. It is shown that many of the results for the inhomogeneous system have a close similarity to the corresponding results for homogeneous systems. In particular, the test-particle theory is exhibited and an expression is obtained for the phase-space density of the polarization cloud associated with a test particle. (auth)

5403 EMISSIVITY IN THE MAGNETO-IONIC MODES. Melrose, D. B. (Yeshiva Univ., New York). Astrophys. J., 154: 803-6(Nov. 1968).

In a recent article in this journal (1967) Mansfield derives the power radiated in the magneto-ionic modes by an electron spiralling in a magnetoplasma. However, he erroneously argues that two terms drop out in the final expression. In this note this error is corrected, and the differences between the results of Mansfield and the more usual expressions for the magneto-ionic modes are pointed out. (W.D.M.)

5404 THERMODYNAMICS AND MAGNETOHYDRODYNAMICS OF WAVE PROPAGATION IN PARTIALLY IONIZED PLASMAS. Kirsten, E.; Vojta, G. (Karl Marx Univ., Leipzig. Experimental Station for Statistical Physics, Leipzig). Monatsber. Deut. Akad. Wiss. Berlin, 9: 666-70(1967). (In German).

A dynamic adiabatic state equation was derived on the basis of the thermodynamics of irreversible processes for a partially ionized plasma with three components. The degree of ionization was taken as time-dependent with relaxation. A full set of magnetohydrodynamic equations was set up for such a plasma and solved after linearization. The dispersion relations obtained for timely and spatially homogeneous waves, which contain all possible wave types and are modified by appropriate members, contain terms for the mean degree of ionization, ionization energy, mean temperature, and relaxation time. If an external magnetic field lies in the direction of wave propagation, there is no effect on the longitudinal wave; however, a left-direction and a right-direction circularly polarized transverse wave forms. These latter are damped by collisions but not by the relaxation, and exhibit different dispersion behavior. If the magnetic field is perpendicular to the wave propagation direction, a transverse wave passes unhindered through the magnetic field, and a coupling develops between the other transverse wave and the longitudinal wave through the magnetic field. These two waves are characterized by a common dispersion relation, and are difficult to decouple. They are additionally damped by the relaxation. (ATD)

5405 GENERATION OF SMEARED OUT ELECTRON BEAMS FOR EXPERIMENTS ON WEAK PLASMA TURBULENCE. Chang, J.; Boehmer, H.; Raether, M. (Univ. of Illinois, Urbana). Rev. Sci. Instrum., 39: 1873-4(Dec. 1968).

It is shown that electron beams, suitable for experiments on weak plasma turbulence, can be produced by passing the beams through aluminum foils of a few-thousand-angstrom thickness. Measurements of the beam distribution function and the transmission as a function of foil thickness are presented. (auth)

5406 EXTERNAL EXCITATION OF SPACE CHARGE WAVES IN A RF DISCHARGE. Sugai, Hideo; Sato, Noriyoshi (Tohoku Univ., Sendai). Kakuyugo-Kenkyu, 21: 223-59(Sept. 1968). (In Japanese).

Standing wave patterns are excited externally in a rf discharge (14 to 32 Mc) by applying continuous sinusoidal currents (1 to 100 kc) to a small coil surrounding the discharge tube in a weak axial magnetic field ($B_0 \lesssim 100$ G). It is experimentally confirmed that there is no reflection of the waves from the boundary along the axial direction. The wavelengths are found to be independent of the exciting frequency, but inversely proportional to the frequency of the rf discharge. They are proportional to the plasma radius and the magnetic field and do not depend on the plasma density and the ion mass. The experimental results of the wavelength are in good agreement with theoretical values for the space charge waves (Trivelpiece mode) propagating along the plasma column in a weak magnetic field. The excitation of the space charge waves, the frequency of which is equal to that of the rf field for the discharge, is well understood by taking into account that the rf field perturbs the local space charge produced by the exciting signals. The waves are modulated in amplitude at the exciting frequencies. The standing-wave patterns observed at the exciting frequencies are attributed to the synchronization of the waves with the rf field for the discharge. (NSA of Japan)

5407 KINETIC EQUATIONS DESCRIBING THREE-WAVE INTERACTION IN A PLASMA. Kurasawa, Takasi (Electrotechnical Lab., Tokyo). Denki Shikensho Iho, 32: 627-31(1968).

A derivation of kinetic equations of three-wave interaction among two electron plasma waves and one ion wave is presented in detail. (auth)

5408 THE MEASUREMENT OF THE IONIZATION WAVES DISPERSION CURVES IN A NITROGEN DISCHARGE PLASMA USING THE TIME-SPACE DISPLAY METHOD. Laska, L.; Exner, V. L. (Inst. of Physics, Prague). Czech. J. Phys., 18: 1472-3(1968).

Dispersion curves of three simultaneously existing types of ionization waves in nitrogen diffuse discharge plasma were measured and are presented. The waves were excited in a dc glow discharge by a sinusoidal voltage signal. (M.O.W.)

5409 ON THE RELAXATION OF ANISOTROPIC PLASMAS WITH DYNAMIC SHIELDING. Lehner, G.; Pohl, F. (Institut fuer Plasmaphysik GmbH, Garching/Munich, Ger.). Z. Phys., 216: 488-98(1968).

The relaxation of a strongly anisotropic two-component-plasma is treated by using the Balescu-Lenard equation, i.e., taking into account collective effects. The relaxation process is described by parallel and perpendicular temperatures as functions of time; it is assumed that the distribution functions remain elliptical. The result is that collective effects are only significant if the ratio of electron and ion temperatures is very small ($<10^{-4}$) or very large ($>10^{+2}$). (auth)

5410 EFFECT OF ELECTRON CYCLOTRON RESONANCE ON HELICON WAVES. Blevin, H. A.; Christiansen, P. J.; Davies, B. (Flinders Univ. of South Australia, Bedford Park). Phys. Lett., 28A: 230-31(Nov. 18, 1968).

Preliminary results are given for helicon propagation in a plasma. The theory is for a nonuniform resistive plasma, and includes the electron cyclotron resonance, which is important even when $\omega \sim \Omega_e/20$. The experimental results are in excellent agreement with the theory. (auth)

5411 QUENCHING OF ION OSCILLATIONS AT THE SHEATH-PLASMA RESONANCE. Lampis, G.; Aihara, S.; Takayama, K. (Nagoya Univ., Japan). Phys. Lett., 28A: 197-8(Nov. 18, 1968).

Ion oscillations are damped by an external rf electric field when the condition of sheath-plasma resonance is reached. (auth)

5412 INSTABILITY OF PERIODIC MAGNETO-ACOUSTIC WAVE. Petviashvili, V. I. (Moscow Inst. of Nuclear Physics). Zh. Tekh. Fiz., 38: 1420-5(Sept. 1968). (In Russian).

Properties of hot plasma or solid-state plasma with periodic magneto-acoustic wave propagation across its magnetic field are discussed. (R.V.J.)

5413 NONLINEAR EXCITATION OF LOW-FREQUENCY PLASMA WAVES. Machabeli, G. Z.; Tsintsadze, N. L. Zh. Tekh. Fiz., 38: 1426-30(Sept. 1968). (In Russian).

Nonlinear excitation of low-frequency longitudinal oscillations was studied in a nonisothermal isotropic plasma with an electron beam. Nonlinear increases of these oscillations were found and are shown to be inversely proportional to the magnitude of the wave potential. Moreover, the nonlinear increase was larger than the increase obtained in linear theory. (R.V.J.)

5414 DRIFT INSTABILITIES IN A CONFINED PLASMA FROM THE FRONT PLASMA COLUMN. Shut'ko, A. V. Zh. Tekh. Fiz., 38: 1431-41(Sept. 1968). (In Russian).

The influence of surface dissipation of front electrodes on the increase of drift instabilities in a plasma column was studied, neglecting the longitudinal ion motion. Data obtained showed that even in the absence of volume dissipation electron drag in the near-electrode layer can cause a buildup of ion-acoustic and gravitational waves. The effect of near-electrode processes on the development of current-convective instabilities was studied. In particular, it was shown that a prefront wave can build up in an ion layer with the amplitude decaying after passing the front. (R.V.J.)

5415 PENETRATION OF LONGITUDINAL ELECTRIC FIELD INTO SEMI-CONFINED PLASMA. Dryakhlushin, V. F.; Romanov, Yu. A. (Gorky State Univ., USSR). Zh. Tekh. Fiz., 38: 1442-8(Sept. 1968). (In Russian).

Kinetic approximation studies were made of longitudinal electric field penetration into semiconfined homogeneous plasma with diffusive reflection of plasma particles from its boundary. Studies were confined to one- and two-component plasmas. Data obtained are compared with published data. (R.V.J.)

5416 STABILITY OF RAREFIED PLASMA SURROUNDED BY SURFACE WITH COMPLEX CONDUCTIVITY. Arsenin, V. V. Zh. Tekh. Fiz., 38: 1449-53(Sept. 1968). (In Russian).

Data on potential oscillations of rarefied plasma surrounded by a surface with a complex conductivity showed that dispersion properties of the surface influence the spectrum of large-scale perturbations. An example of low-frequency flute and drift-type cyclotron oscillations show that a poorly conducting surface has dissipative instabilities excited in it. It is also shown that the presence of inducting surfaces reduced the density threshold of cyclotron instability related to the anisotropic ion distribution function. (tr-auth)

5417 ACOUSTIC WAVES INDUCED IN A GAS BY CURRENT PULSE. Kozlov, Yu. G.; Shukhtin, A. M. (Leningrad State Univ.). Zh. Tekh. Fiz., 38: 1465-71(Sept. 1968). (In Russian).

Conductivity of gas-discharge plasma was studied during its decay at pulsed discharge in inert gases and mean (5- to 15-mm Kg) pressures. Longitudinal and radial acoustic oscillations excited by current pulses at various stages of plasma decay were observed. The experiments revealed various types of oscillations with frequencies related to the temperature, gas molecular weight, and geometry of the discharge tube. The data on free acoustic oscillations are suggested for low-temperature plasma diagnostics. (R.V.J.)

5418 AMBIPOLAR DIFFUSION IN THE BOUNDARY LAYER BEHIND THE SHOCK WAVE. Burminskii, E. P.; Goryachev, V. L.; Sukhov, G. S. Zh. Tekh. Fiz., 38: 1482-9(Sept. 1968). (In Russian).

The laminar boundary layer behind a shock-wave front was studied, considering the ambipolar charged-particle diffusion. The results are compared with experimental data obtained using a gaso dynamic shock tube filled with argon at a pressure of 1-mm Kg and $M_s = 10$ (shock wave Mach number). (tr-auth)

5419 TOTAL ENERGY OF A WAVE IN PLASMA. Saison, R.; Tasso, H. (Institut fuer Plasmaphysik GmbH, Garching, Ger.). Z. Naturforsch., 23a: 1665-6(Oct. 1968).

The total mode energy in a plasma is derived from the expression of the energy to second order. This mode energy agrees with that usually given in the literature for wave packets. (auth)

5420 COLLECTIVE FRACTION IN PLASMA MICROFIELDS. Hunger, K.; Larenz, R. W. (Technische Univ., Berlin. Univ., Duesseldorf). Z. Naturforsch., 23a: 1488-98(Oct. 1968). (In German).

The Holtsmark microfield evaluation is rediscussed. It is shown that in the usual computation of the Fourier transform a term is neglected which has the dimension of a dipole moment density.

This term occurs only for long range forces (here Coulomb ones) and remains undetermined in the limit of an infinitely large system without interaction. Furthermore, it is sensitive to deviations from ergodicity. The true microfield distribution results as a Holtsmark distribution centered at the generally nonvanishing far field. As the distribution of the latter is Gaussian the complete distribution results as a convolution of the Holtsmark distribution with that of the far field. The parameter of the Gaussian far-field distribution is computed for a noninteracting plasma, consisting of N charges, by taking into account explicitly the collective field of space-charge fluctuations. The formulas arrived at with respect to the microfield, as well as the micropotential, suggested performing numerical computer experiments (Hunger, Larenz and Wilke, to be published). For an interacting plasma, the far field is obtained qualitatively. It agrees with the microfield of Hunger and Larenz (1961). The far field dominates the Holtsmark nearest-neighbor field at plasma conditions $kT/e^2n^{1/3} > 1$. (auth)

5421 STATISTICAL STRUCTURE OF NONISOTHERMAL ELECTRON–ION PLASMA. Martinov, N.; Nikolov, N. (Sofia Univ.). Compt. Rend. Acad. Bulg. Sci., 21: 757-60(1968).

The statistical polarization of a bicomponent electron-ion plasma is discussed without any additional conditions as regards quasi neutrality and isothermicity and without the use of the linearizing condition $|e\phi| \ll \theta$. The velocity distribution of the particles is considered to be of the Maxwell–Boltzmann type. The stationary case of hydrodynamic equilibrium of a system in which there are no macrostreams will be dealt with, the plasma representing a one-dimensional semi-infinite system bounded at x = 0 by a solid wall (metal or dielectric). (M.O.W.)

5422 FINITE-AMPLITUDE DRIFT WAVES IN AN UNSTABLE PLASMA. Shut'ko, A. V. Zh. Eksp. Teor. Fiz., 55: 1947-52(Nov. 1968). (In Russian).

Nonlinear equations describing drift oscillations of an inhomogeneous plasma with collisions are studied for the case of the plasma in a strong magnetic field. It is demonstrated that, due to competition between nonlinear damping and linear buildup, a stationary drift wave may asymptotically be established in such a plasma. (auth)

5423 QUASI-LINEAR APPROXIMATION FOR A MAGNETO-ACTIVE PLASMA WITH ALLOWANCE FOR COLLISIONS. THE CHERENKOV EFFECT. Logvinov, V. V.; Machabeli, G. Z. Zh. Eksp. Teor. Fiz., 55: 1953-63(Nov. 1968). (In Russian).

A kinetic equation for a "slow" distribution function of a magneto-active plasma is obtained in the quasi-linear approximation by taking into account particle collisions. The equation can be employed for analysis of the interaction between particles and various types of high-frequency electromagnetic waves in a plasma. The momentum and energy balance equations for various plasma components are derived from the equation for the case of Cherenkov resonance on the condition that the component distribution functions are Maxwellian with a temperature and a directed velocity anisotropy. Electron beams and electron heating due to nonlinear action of various types of high-frequency fields are determined in the steady state. It is shown that in the quasi-linear approximation, when the wave energy is sufficiently small, transverse waves, in the case of waves moving along a magnetic field, do not produce a directed velocity and electron heating. Longitudinal waves, on the other hand, result in the appearance of a current along the wave vector and also in anisotropy of the electron temperature (the longitudinal component of the electron pressure is greater than the transverse component) and heating of electrons relative to the ions. In the case of waves moving in a plane perpendicular to the magnetic field, the transverse waves can produce a much greater nonlinear current than longitudinal waves moving along the magnetic field. However, longitudinal waves propagating perpendicular to the magnetic field, in this approximation, in general, do not produce a current or electron heating. For waves moving at an angle with respect to the magnetic field, the contribution of the transverse wave component to the nonlinear current along the magnetic field may be considerable and exceed the respective contribution from the longitudinal waves. In conclusion, the longitudinal (with respect to the magnetic field) component of the electron distribution function is determined on the basis of the model collision integral in which anisotropy of the electron temperature is taken into account. (auth)

5424 NONLINEAR EFFECTS IN PROPAGATION OF WAVES IN BOUNDED PLASMA. Chakraborti, B. (Moscow State Univ.). Vestn. Mosk. Univ., Ser. III. Fiz.. Astron., No. 5, 99-105(1967). (In Russian).

Previous work which deals with developing a theory for the solution of the Vlasov equation for nonlinear effects in plasmas, is extended to include a plane plasma boundary. It is assumed that a plane monochromatic wave, incident at an angle from the vacuum side, acts as a perturbation source in the plasma. In the third approximation this perturbation results in first and third transverse wave harmonics. In this third approximation the distribution function is developed, and a correction to the wave number is obtained. This correction depends on the square of the original wave amplitude. Boundary conditions are obtained for the transverse wave in the third approximation. The existence of surface charges on the plasma boundary is discussed, and the wave amplitude in the third harmonic is calculated on the lower boundary of the plasma layer. (ATD)

5425 NUMERICAL SOLUTION OF PROBLEM ON NONLINEAR PLASMA OSCILLATIONS. Telegin, V. I. Vestn. Mosk. Univ., Ser III Fiz. Astron., No. 5, 25-34(Sept.-Oct. 1968). (In Russian).

Numerical solution of the Cauchy problem using the Vlasov equation was used in studies of interactions of longitudinal Langmuir waves with plane waves in an infinite homogeneous plasma. A spectrum of relatively highly excited oscillations and some nonlinear properties of plasma were found in wide ranges of temperature and amplitudes of initial perturbation. (tr-auth)

5426 ELECTRICAL CHARACTERISTICS OF THE POSITIVE COLUMN IN BINARY RARE-GAS MIXTURES WITH MERCURY VAPORS. Zaitsev, A. A.; Miskinova, N. A.; Nguyen Hiu Tee. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 5, 35-41(Sept.-Oct. 1968). (In Russian).

Experimental data obtained on the magnitude of electron temperature, electric field, electron density, rate of ionization, and electron mobility in mixtures of inert gases (helium, neon, and argon) with mercury vapors are compared with the theoretical data. (tr-auth)

5427 ELECTRON–NEUTRAL MOMENTUM TRANSFER CROSS SECTIONS AND CONDUCTIVITY RATIOS IN SOME RARE GASES. Hoffmann, Clarence Robert John. Saskatoon, Saskatchewan, Univ. of Saskatchewan, 1968. 114p.

Thesis.

Conductivity ratios have been measured as functions of electron temperature in weakly ionized helium, neon, krypton, and xenon plasmas. The measurements, which provide information on the momentum transfer cross sections for electron–neutral atom collisions, were carried out in the afterglow of a repetitively pulsed electrodeless radio frequency (3.5 mHz) discharge produced in a racetrack-shaped container in the presence of a dc magnetic field. A microwave resonant-cavity technique (2.7 GHz) is used to measure the complex plasma admittance without causing any significant perturbation of the plasma. Under certain conditions, which are discussed in detail, the plasma admittance is directly related to the conductivity ratio. Unlike previous experiments of this kind, the electron temperatures are measured directly. This is accomplished by using a gated microwave radiometer technique that compares the microwave radiation originating in the plasma in a small bandwidth (at 4 GHz) to that from a known-temperature black-body noise source. Adjustable electron temperatures from 300 to 10,000°K were obtained at the desired electron density ($\sim 2 \times 10^{16}$ m^{-3}) by applying a low-level pulsed rf heating field prior to the time of measurement. The conductivity ratios for helium and neon agree with those of other workers at low electron temperatures but diverge from them toward higher temperatures. The conductivity ratio measurements for krypton and xenon are new. The helium results support the momentum transfer cross sections obtained by applying the effective range of O'Malley to the total cross section measurements of Golden and Bandel. Momentum transfer cross sections for electron–neutral collisions in neon are determined from the conductivity ratio data using the technique of Phelps, Fundingsland and Brown. These cross sections are considered accurate to ±6% for electron energies in the range 0.04 to 1.0 eV and lead to a scattering length for neon of +0.23 a_0. Comparison of the krypton and xenon conductivity ratios with calculated values obtained from the momentum transfer cross sections of Frost and Phelps shows that their cross sections are too large in the region of the Ramsauer minimum to explain the measured values. (Diss. Abstr.)

5428 EFFECTS OF WALL PERMITTIVITY AND PLASMA THICKNESS ON THE PLASMA REFLECTION COEFFICIENT. Shockley, T. D. Jr. (Memphis State Univ.); Haden, C. R.; Bowie, J. L. Indian J. Phys., 42: 151-3(Mar. 1968).

The equation defining the E-field reflection coefficient for a bounded homogeneous plasma slab is solved numerically. Representative computer results are presented which indicate that the magnitude of the reflection coefficient can be maximized by choosing a wall material with the proper permittivity or by choosing the proper plasma width. (auth)

5429 TRANSMISSION OF RADIATION IN A PLASMA. Kogan, V. I.; Abramov, V. A.; Vasil'ev, A. P. (Kurchatov Inst. of Atomic Energy, Moscow). J. Quant. Spectrosc. Radiative Transfer, 8: 1833-49(Dec. 1968). (In Russian).

A simple analytical treatment of the transfer of radiation in resonance lines and in the recombination continuum is made, postulating complete frequency redistribution during re-emission. The influence of the form of the kernel of the integral transfer equation on the characteristic of its solution is examined. Particular attention is given to optically very dense systems, remote from thermal equilibrium. Results are derived which are independent of the form of the kernel. Two basic kinds of radiation transfer, and the corresponding diffusion and "anti-diffusion" approximations, are considered. The steady-state problem and its association with the nonsteady-state problem are discussed. A new kind of approximate solution to the stationary problem is suggested, "invariant" in relation to the type of transfer. An elementary treatment of nondiffusion transfer is given. Various characteristic lengths, which occur in the problem of transfer through optically dense media with weak quenching, are examined; in particular, the "occlusion length", which enables the regions of volume and surface radiation in a plasma of finite dimensions to be delimited. (auth) (UK)

5430 THERMAL RADIATION OF NITROGEN PLASMA OVER THE RANGE 0.5 TO 1.1 μ. Kupriyanova, E. B.; Kolesnikov, V. N.; Sobolev, N. N. (Lebedev Inst. of Physics, Moscow). J. Quant. Spectrosc. Radiative Transfer, 8: 1851-61(Dec. 1968). (In Russian).

The absolute radiation intensities of molecular nitrogen were measured in the spectral range from 0.5 to 1.1 μ at 6900°K and a pressure of 1 atm. An arc discharge was used as the light source. This technique of molecular nitrogen excitation makes it possible to obtain a purer plasma than the use of shock tubes. It was shown experimentally that the state of the plasma was close to LTE. The role of plasma heterogeneities is discussed in detail. The purity and stability of the plasma allowed reduction of the error of the measurements to 15%. A comparison of the intensities measured with the results of other experiments and calculations was made. (auth) (UK)

5431 ELECTRON FLUX INSTABILITY IN CROSSED MAGNETIC AND NON-HOMOGENEOUS ELECTRIC FIELDS. Korsunskii, A. M.; Khizhnyak, N. A. (Kharkov State Univ.). Zh. Tekh. Fiz., 38: 1490-9(Sept. 1968). (In Russian).

Instability of two-beam electron flow moving under a certain angle to the magnetic field was studied in linearized hydrodynamics and Langrangian approximations. Dispersion equations were obtained for two-beam systems as functions of beam parameters and the direction of their motion in relation to the external field. The initial stages of oscillations and the instabilities in longitudinal waves were studied. (R.V.J.)

5432 FREE-SPACE ELECTROMAGNETIC SCATTERING FROM A PLASMA COLUMN. Butterworth, Joseph Edward. Lafayette, Ind., Purdue Univ., 1968. 290p.

Thesis.

Laboratory measurements of electromagnetic scattering from the positive column of a low-pressure (1.2-torr) discharge in mercury under steady-state conditions are described. Both amplitude and phase of the scattered electric field are measured for TE and TM polarizations over a 2.6- to 5.85-GHz frequency range. Two scattering experiments are performed for each of eight test frequencies in the above band: (1) a measurement of the scattered field vs discharge current at constant diffraction angle, which determines the resonant frequencies; and (2) a measurement of the scattered field vs diffraction angle at carefully chosen constant currents, which determines the angular variation of the various resonances. (Diss. Abstr.) (TSS)

5433 DENSITY DISTRIBUTION OF A CYLINDRICAL PLASMA. Ma, Chao-hung. Salt Lake City, Univ. of Utah, 1968. 175p.

Thesis.

The theory of ambipolar diffusion for a dc discharge plasma in a nonuniform magnetic field is carried out, based on the assumption that the distribution function of the ions and electrons satisfies the collisionless Boltzmann equation. The theoretical plasma density profiles predict a plasma density peak in the increasing magnetic field region. A short microwave cavity was used to measure the relative axial density variations, and a comparison between experiment and theory gives reasonable agreement. A static theory of density and potential distribution in a cylindrical electron-beam-generated plasma with zero magnetic field is developed. Electron and ion density profiles are obtained. A long cavity was used to measure the electron density and double-probe measurements were performed to obtain the radial variation of the ion density. It is found that the theory and experiment are in good agreement. A theory of ambipolar diffusion for a cylindrical beam-generated plasma in a uniform magnetic field is derived. The relations between plasma density and the beam and the gas parameters are obtained and density profiles are predicted. Both microwave-cavity and double-probe measurements were conducted. A comparison between the results of this theory and experiment and some density measurements on beam-generated plasmas reported in the literature gives fair agreement. (Diss. Abstr.)

5434 NONLINEAR WAVE INTERACTIONS IN A HIGHLY IONIZED PLASMA. Boone, Jack Llano. Denver, Univ. of Denver, 1968. 77p.

Thesis.

The interaction of a large-amplitude disturbing wave with a thermally generated, highly ionized cesium plasma has been investigated using a small-amplitude sensing wave as a probe. The subsequent interaction between the disturbing and sensing waves is related to the plasma electron temperature. The plasma is contained in a magnetic field of 500 to 1000 gauss and has an electron plasma frequency near 10 GHz and an electron gyromagnetic frequency around 2 GHz. The sensing wave was a 10-GHz plane wave of approximately 1.5 mW input power and the disturbing wave was 7.5-GHz plane wave of about 1.2 W peak power. Measurements of the sensing wave transmitted power were made using standard microwave techniques. A notch filter in the sensing wave receiving circuit reduced the scattered disturbing wave interference to an immeasurably low level. Langmuir probes were used to detect disturbing wave modulation and to measure plasma temperatures and densities. Measurements of the interaction were correlated with a solution of the Boltzmann transport equation for a perturbed Maxwellian distribution function with binary Coulomb collisions. (Diss. Abstr.)

5435 RADIAL DIVERGENCE OF A RAREFIED PLASMA IN H_{11} WAVE FIELD. Gekker, I. R. Zh. Tekh. Fiz., 38: 773-6(Apr. 1968). (In Russian).

This is a continuation of earlier work (Proceedings, Seventh International Conference on Phenomena in Ionized Gases, Belgrade, 1965) dealing with the interaction of the low-density plasma with an H_{11} wave. The present paper is devoted to the motion of a plasma in a strong field of a linearly polarized wave H_{11} when plasma is injected in the direction of the axis of a round waveguide. The procedure and apparatus are described briefly. Calculations of the equations of motion of the particles under the geometry used in the earlier study are also presented. The results show that the particles experience an azimuthally asymmetric particle divergence in a linearly polarized H_{11} wave. This divergence appears at voltage exceeding 0.5 kV/cm. This divergence depends on the mass of the ions in the plasma (atomic hydrogen, molecular hydrogen, and carbon) and is attributed to the presence of gradient forces. The agreement between the calculated and experimental values of the plasma divergence is satisfactory, and it is concluded that the process of interaction between the plasma and the H_{11} wave can be used for a mass analysis of a plasma beam. (ATD)

Production

5436 (JPRS-46727) NINE PLUS ONE: A NEW DISCOVERY IN PLASMA PHYSICS. Yur'ev, P. Translated from Znanie-Sila, 43: No. 6, 30-1(1968). 8p. CFSTI.

During computer studies of the expansion of a hot plasma cylinder in a parallel magnetic field, a new effect was discovered. An unexpected surge developed on the theoretical temperature curve, and it was established that not all the gas is cooled during expansion—at a certain instant, a high-temperature zone appears, named the "T-layer." This discovery has been titled as "Nonlinear Effect of Formation of a Self-Sustaining High-Temperature Electrically Conductive Layer in a Compressible Medium Moving in a Magnetic Field." Some remarks are given on numerical experiments and possible applications of the discovery. (D.L.C.)

5437 IONIZING ACTION OF RADIATION DUE TO HEATING OF SUBSTANCE IN THE FOCUS OF A LASER BEAM AND PRODUCTION OF A PLASMA WITH HIGH DEGREE OF IONIZATION. Arifov, T. U.; Askar'yan, G. A.; Tarasova, N. M. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 8: 77-9(Aug. 5, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 128-32(Aug. 5, 1968).

When a laser beam is focused on a substance, the latter can be heated to high temperatures, on the order of several dozen electron volts, at which hard ultraviolet and x-ray emission is produced. It is shown here that such radiation has a strong ionizing effect, thus evidencing high intensity. It is indicated that this radiation can play an important role in the production

of highly ionized plasma, since it ionizes the neutral atoms ejected together with the plasma when the laser acts on the substance. (M.H.R.)

5438 LASER-PRODUCED SPARKS IN A 200-kG MAGNETIC FIELD. Chan, P. W.; DeMichelis, C.; Kronast, B. (National Research Council of Canada, Ottawa). Appl. Phys. Lett., 13: 202-3(Sept. 15, 1968).

Laser-produced sparks in air, butane, and helium at atmospheric pressure have been studied in a 200-kG magnetic field. The influence of the magnetic field on the breakdown threshold, on the visible radiation emitted by the plasma, and on the plasma expansion has been investigated. (auth)

Stability

Refer also to abstract 5431.

5439 ON POSSIBILITY OF PLASMA CURRENT COLUMN STABILISATION BY FEEDBACKS. Arsenin, V. V.; Chuyanov, V. A. At. Energ. (USSR), 25: 141-2(Aug. 1968). (In Russian).

It is known that a plasma current loop, which is contained by its own magnetic field, should be unstable with respect to small deviations from the equilibrium position. If the loop has a finite length (closed torus), the most dangerous perturbations (necking and spiraling) can be suppressed by imposing a sufficiently strong, external, horizontal magnetic field. In this case, the condition of stability with respect to spiraling limits the current in the discharge loop. A simple system which is controlled by the perturbed field outside the plasma is proposed. The system should react to one of the components of the variable magnetic field at the surface of the loop. This field is related to the displacement of the plasma boundary by a rather complicated function depending on the wave numbers. It is shown that if such a system is used in addition to an external longitudinal field, the current condition is relaxed. (TTT)

5440 STABILITY INTEGRALS FOR LINEAR MULTIPOLE CONFIGURATIONS. Tanaka, Masatoshi; Tamura, Sanae (Japan Atomic Energy Research Inst., Tokyo). Kakuyugo-Kenkyu, 21: 202-22(Sept. 1968). (In Japanese).

Analytical results are presented for two plasma stability integrals $\oint dl$ and $\oint dl/B$ for the linear quadrupole, hexapole, and octapole magnetic field configurations. In case of symmetric distribution of current filaments, they can be expressed in terms of the complete elliptic integral of the first kind. The stability limit lines defined by $(\partial/\partial\psi)\oint dl = 0$ and $(\partial/\partial\psi)\oint dl/B = 0$ (ψ: flux function) are determined together with the magnetic mirror ratios on those flux lines. Nonsymmetric linear hexapole configurations are also discussed briefly. (NSA of Japan)

5441 INSTABILITIES IN A LOW-PRESSURE DISCHARGE IN A TRANSVERSE MAGNETIC FIELD. Kerealishvili, N. A. Zh. Tekh. Fiz., 38: 770-3(Apr. 1968). (In Russian).

An investigation was made of the oscillations of the electron current from the discharge along the magnetic field to disc cathodes, of the ion current from the discharge to a solidical cathode, and of the discharge current in a discharge tube of the inverted magnetron type, the construction and dimensions of which are presented in earlier papers (Zh. Tekh. Fiz., 38: 637(1968), and elsewhere). The tests revealed the presence of relaxation oscillations of the ion and electron current in the entire range of the investigated discharge parameters. These oscillations of the ion and electron current constituted periodic pulses against the background of a dc component. The amplitudes of the pulses greatly exceeded the mean value. Since these pulses are in phase and cancel each other, they affect the discharge current little. The amplitude of the pulses and their frequency depend considerably on the relative orientation of the anode and of the magnetic field. There exists a critical field in which the influence becomes small. Plots of the characteristics of the pulses on the anode orientation and on the discharge parameters are presented. (ATD)

Shielding

Refer also to abstracts 5765, 5772, 5785, and 5798.

5442 (AD-671688) A FORTRAN SOURCE-ENERGY INTEGRATION PROGRAM FOR THE NGM CODE OUTPUT. Beverly, William B.; Lacetera, Joseph (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). June 1968. 31p. (NDL-TM-43). CFSTI.

A digital computer program written for the GE 225 Computer (16K core storage and 6 magnetic tape drives) in the Tape FORTRAN language is described. It differs from the original program (See AD-645 929) in that a complete detector is read into the computer memory at one time which allows a faster and more efficient program. The program integrates the LASL NGM radiation transport code differential flux output with respect to the source-energy variable weighted by a user-supplied function. The resultant output is the flux at the detectors due to the user-supplied source-energy spectrum. The method of performing the weighted source-energy integration operation and the use of checks to minimize error are given through the use of a flow diagram with complementary textual description and FORTRAN source-deck listing. The method of program operation and proper response to error signals are also described. (auth) (USGRDR)

5443 (AI-AEC-Memo-12693) SOSUM: A PROGRAM TO COMPUTE MULTIGROUP BETA AND GAMMA ENERGY SOURCES FROM RADIOISOTOPE ACTIVITIES. Dray, B. J.; Thomson, R. J. (Atomics International, Canoga Park, Calif.). June 3, 1968. Contract AT(04-3)-701. 40p. Dep. CFSTI.

The fission-product inventory codes generally used in safety studies compute the isotopic radioactivity in curies or disintegrations/sec. In shielding or heating calculations, the energy sources and spectra are important. The SOSUM code was written to compute multigroup beta and gamma energy sources from radioisotope data. A discussion of the program and its built-in library, general input instructions, and a sample problem are presented. The complete listings for S/360 of the main program and the library are included. (auth)

5444 (ORNL-tr-1911) CALCULATION OF THE ENERGY DISTRIBUTION OF HIGH ENERGY NEUTRONS IN A SHIELD. Sychev, B. S. Translated for Oak Ridge National Lab., Tenn., from report JINR-P16-3593. 30p. Dep. CFSTI. fs, $1.10 mf.

An abstract for the original paper appeared previously in NSA 22: 7337. (M.O.W.)

5445 (ORNL-tr-1923) CALCULATIONS OF ELECTROMAGNETIC SHOWERS IN LEAD WITH AN INITIAL ENERGY OF 6 GeV. Varfolomeev, A. A.; Drabkin, L. B. Translated for Oak Ridge National Lab., Tenn., from report IAE-1201. 24p. Dep. CFSTI.

An abstract for the original paper appeared previously in NSA 21: 40165. (M.O.W.)

5446 (ORNL-tr-2017) CALCULATION OF A NUCLEON CASCADE IN ALUMINUM WITH THE MONTE CARLO METHOD FOR ENERGIES BETWEEN 400 AND 30 MeV. Locci, M. A.; Picchi, P.; Verri, G. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Translated for Oak Ridge National Lab., Tenn., from report LNF-65/30. 17p. Dep. CFSTI.

An abstract of the original paper appeared previously in NSA 20: 8274. (M.O.W.)

5447 HEAVY PLASTIC CONCRETE: MATERIAL FOR RADIATION SHIELDING. Loginov, V. S.; Kashkovskaya, E. A.; Astaf'ev, N. A. Beton Zhelezobeton, No. 4, 20-1(1968). (In Russian).

Heavy plastic concrete made with polyester resin and barite sand exhibits high density and provides enhanced shielding against neutron radiation because of the high hydrogen content of the resin. The properties of two plastic concretes were studied with specimens of various compositions. The shielding properties of the plastic concretes against γ and neutron radiation were shown to exceed those of conventional concretes by 150% and 7600%, respectively. Other advantages of plastic concretes include: better mechanical properties and higher corrosion resistance than those of limonite, magnetite or barite cement concretes; enhanced hardness; low wear; fast hardening. Plastic concrete is recommended as a material for radiation shielding. (ATD)

5448 GAMMA HEATING IN THIN HEAVY-ELEMENT ABSORBERS. Lynch, John H.; Crum, Richard J.; Reilly, Harry J. (Lewis Research Center, Cleveland). Nucl. Appl., 5: 456-63 (Dec. 1968).

The ratio of gamma heating in tungsten to that in an equal volume of water is calculated for the case of a thin tungsten detector in a water shield. One-dimensional transport theory calculations yielded response polynomials that predict this ratio as a function of source energy, shield thickness, and detector thickness. Electron transport effects and useful results are presented in the form of graphs. The results are applied to reactor irradiation experiments. (auth)

5449 ZASHCHITA OT GAMMA-IZLUCHENIYA PRODUKTOV DELENIYA. (Handbook on Shielding Against Gamma Radiation of Fission Products). Gusev, N. G. Moscow, Atomizdat, 1968. 388p.

The handbook offers the basic data on the radiation characteristics and shielding against γ radiation from fission products

in nuclear reactors or nuclear explosions. Radiation characteristics, differential and total activity, and γ equivalents are discussed. Effective radiation spectra are calculated for ^{235}U and ^{239}U fission products produced in reactors by thermal neutrons, and fission neutrons, and for instant ^{239}U fission by 14-MeV neutrons. Calculations for shielding from γ sources and for radiological protection are analyzed. Tables and nomograms present universal data for shielding and radioprotection. 48 references. (R.V.J.)

Solid-State Physics

Refer also to abstracts 4688, 4857, 4861, 5078, 5085, 5663, and 5671.

5450 (BNWL-903) A REVIEW OF LARGE POLARONS IN THE LOW TEMPERATURE LIMIT AND OF SMALL POLARONS IN THE HIGH TEMPERATURE LIMIT. Sevenich, Richard A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1968. Contract AT(45-1)-1830. 59p. Dep. CFSTI.

A comprehensive review is given of the theory of large polarons in the low-temperature limit and of small polarons in the high-temperature limit. Where possible, reference is made to the applicability of small polaron theory to electrical conduction in some metal oxide insulators. The purpose of the report is to give the theoretical foundations and approximations inherent in small polaron theory in order to facilitate applications of the theory toward explaining electrical conduction in some metal oxide insulators. (auth)

5451 (COO-1247-13) QUENCHING PLATINUM AND TUNGSTEN IN SUPERFLUID HELIUM. Gripshover, Ronald; Zetts, John; Bass, Jack (Michigan State Univ., East Lansing. Dept. of Physics). Aug. 1968. Contract AT(11-1)-1247. 7p. Dep. CFSTI.

Quenches were carried out on platinum wires into various liquids and in superfluid helium, and tungsten wires in superfluid helium. At high temperatures, the resistivities quenched into fine platinum wires cooled in superfluid helium are consistent with those quenched into larger wires plunged into water and kerosene. However, there is reason to believe that the platinum and helium interact in a manner which does affect the results obtained. The resistivities quenched into high-purity 0.001- and 0.0012-inch dia tungsten wires ($R_{273°K}/R_{4.2°K} > 600$) are comparable to Schultz's published results. However, some differences do exist. (auth)

5452 (NYO-3842-5) RADIATION-INDUCED DEFECTS IN ALKALI HALIDES, AND THEIR ROLE IN RECOMBINATION PROCESSES. Annual Progress Report, March 1, 1968–February 28, 1969. Murray, R. B. (Delaware Univ., Newark. Dept. of Physics). Nov. 22, 1968. Contract AT(30-1)-3842. 6p. Dep. CFSTI.

ALKALI METAL HALIDES — radioinduced V_k centers in crystals of, research program on properties of
POTASSIUM BROMIDES — radioinduced anion vacancies in thallium-doped, studies of x
RUBIDIUM IODIDES — V_k center diffusion in, activation energy for
SODIUM CHLORIDES — radioinduced centers in thallium-doped, absorption spectra of x
X RADIATION — effects on alkali metal halide crystals, studies of V_k centers produced in (D.L.C.)

5453 (SC-DC-68-1985) THERMAL CONDUCTIVITY OF ELECTRON IRRADIATED CdS. Vook, Frederick L. (Sandia Corp., Albuquerque, N. Mex.). Apr. 1968. Contract AT(29-1)-789. 13p. (CONF-680716-1). DTIE.

From 9th Conference on the Physics of Semiconductors, Moscow, USSR.

The thermal conductivity of pure CdS single crystals after 2-MeV electron irradiation at temperatures below 25°K was investigated. The measurements were made with the temperature gradient parallel and perpendicular to the c-axis. The additive thermal resistivity at 11°K is fitted by: $1/k - 1/k_0 = 5.5 \times 10^{-10}\ \phi^{0.5}$ cm-deg/W, where ϕ = electron flux. Annealing begins at ~35°K and is completed below 300°K, with stages at ~60 and 200°K. The temperature dependences of the thermal conductivity at various anneal temperatures are shown for both c-parallel and -perpendicular directions. It is concluded that the primary defects in CdS are mobile at low temperatures (35°K), and that anisotropic defects are formed upon annealing which at low temperature line up parallel to the c axis and which orient randomly above 20°K. The activation energy of rotation of the defects is determined to be 1.5×10^{-2} eV. (D.L.C.)

5454 NEUTRON DIFFRACTION STUDY OF THE ^{160}Gd SINGLE CRYSTAL. Kuchin, V. M.; Somenkov, V. A.; Shil'shtein, S. Sh.; Patrikeev, Yu. B. Zh. Eksp. Teor. Fiz., 55: 1241-7(1968). (In Russian).

The isotopic single crystal ^{160}Gd was investigated at temperatures from liquid nitrogen to room temperature by the neutron diffraction technique. It was found that for all temperatures below T_c gadolinium is a normal ferromagnetic substance. However the direction of the magnetic moment strongly depends on the temperature. The distribution of the spin density in metallic gadolinium is in good agreement with the calculation for Gd^{3+}. (auth)

5455 THERMAL DESTRUCTION OF F CENTERS AND DIELECTRIC LOSSES IN NaCl AND KCl CRYSTALS. Ismailov, Sh. I.; Evstifeev, Yu. N. (State Pedagogical Inst., Kirgiz, SSR). Sov. Phys.-Solid State (Eng. Transl.), 10: 1322-4(Dec. 1968).

Translated from Fiz. Tverd. Tela, 10: 1674-7(June 1968).

A study was made of the thermal destruction of F centers generated in NaCl and KCl crystals by x rays. The temperature dependence of dielectric losses was studied in the region of intense thermal destruction of these centers (300 to 450°K). It is shown that in the temperature range, 300 to 450°K, a change in the relaxation dielectric losses occurs in the x-irradiated crystals. A comparison of the results of studies of thermal bleaching and of dielectric losses suggests that the hypothesis about the ionic mechanism of thermal destruction of the F centers in the crystals studied is likely to be correct. On the basis of this hypothesis, the direct thermal ionization energy was found for the ionic decomposition products of the F centers in NaCl: Q_i = 0.75 eV. (auth)

5456 THERMAL STABILITY OF URANIUM FISSION FRAGMENT TRACKS IN MUSCOVITE SINGLE CRYSTALS (EFFECT OF ANISOTROPY). Geguzin, Ya. E.; Vorob'eva, I. V.; Berzina, I. G. (Gorky State Univ., USSR). Sov. Phys.-Solid State (Eng. Transl.), 10: 1431-4(Dec. 1968).

Translated from Fiz. Tverd. Tela, 10: 1819-23(June 1968).

An experimental study is made of the rate of change of length of regions formed in specimens of mica (muscovite) by the passage through the crystal of ^{235}U fission fragments, the regions being exposed by a corrosive etchant. The experiments involved isothermal anneals at four different temperatures: 440, 470, 500, and 530°C. It is shown that there is a pronounced dependence of the rate of shortening of a damaged region (track) on the angle (θ) between the orientation of the track and the natural cleavage plane of the crystal. The anisotropy displayed by the track healing rates is related to the anisotropy of the diffusion coefficient D in the crystal by $\nu(\theta) \sim D(\theta + \pi/2)$. A possible mechanism of track healing is suggested. (auth)

5457 THE MOESSBAUER EFFECT. Mukerji, Ambuj; Coulter, C. A. (Army Missile Command, Redstone Arsenal, Ala.). pp 139-83 of Topics in Fields and Solids. Coulter, C. Alton. Shatas, Romas A. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

The theory of the nuclear Moessbauer effect and its optical analog is presented. Introductory paragraphs deal with the destruction of resonance fluorescence in case of a freely recoiling nucleus. The partial restoration of resonance by Doppler effect and thermal broadening is outlined. The concept of zero-phonon transitions between bound nuclear states of nuclei embedded in a crystalline lattice is introduced in a simple quantum mechanical language. The classical derivation of the Debye–Waller factor based on the frequency modulation concept is followed by a rigorous quantum mechanical calculation of the zero-phonon transition probability and its temperature dependence. Lipkin's sum rule is discussed. Application of the Moessbauer effect to determine lifetimes of excited states, nuclear quadrupole moments, and the isomeric shifts is shown. The optical analog in defect solids is described. (auth)

5458 INTERACTION OF ELECTRONS WITH GERMANIUM SINGLE CRYSTALS. Titov, A. I. (Polytechnical Inst., Leningrad). Sov. Phys.-Solid State (Eng. Transl.), 10: 1489-90(Dec. 1968).

Translated from Fiz. Tverd. Tela, 10: 1891-3(June 1968).

The dependence of secondary emission σ and radioinduced conductivity κ on the incident angle ϕ of the primary electron beam was investigated for Ge single crystals at beam energies of 0.6 to 6 keV. The primary beam was always in a {111} plane, and the normal to the surface was in the same plane and at 6° with the ⟨112⟩ direction. The fine structure (maxima in $\sigma(\phi)$ and minima in $\kappa(\phi)$) corresponded to the low-index crystallographic directions. The maxima in $\sigma(\phi)$ were approximate mirror images of the minima in $\kappa(\phi)$. The $\sin\theta$ vs λ relation was found to be linear over the range 1 to 6 keV. (θ = angle between ⟨112⟩ and nearest maximum of κ or minimum of σ, and λ = de Broglie wave-

length of the electrons.) The various models and theories advanced in the literature for explaining the fine structure are criticized, and the point of view of the dynamic theory of electron diffraction is considered. (D.L.C.)

5459 MOESSBAUER SPECTRUM OF ^{237}Np AFTER ALPHA DECAY OF ^{241}Am IN A THORIUM LATTICE. Aleksandrov, B. M.; Kalyamin, A. V.; Krivokhatskii, A. S.; Lur'e, B. G.; Murin, A. N.; Romanov, Yu. F. (Leningrad State Univ.). Sov. Phys.-Solid State (Eng. Transl.), 10: 1494-5(Dec. 1968).

Translated from Fiz. Tverd. Tela, 10: 1896-8(June 1968).

A source of ^{241}Am (~0.1 wt %) in Th metal was prepared, and the Moessbauer spectrum was recorded at 77°K with a NpO_2 absorber at 59.6 keV. The maximum observed effect is 0.75 ± 0.10%, compared to ~1% for a source of AmO_2 or $AmO_2(NpO_2)$, indicating that the thermal aftereffect is unimportant. The line half-width is 1.7 ± 0.2 mm/sec, compared to 2.5 mm/sec for an $AmO_2(PuO_2)$ source. The chemical shift of the line is 3.4 ± 0.2 mm/sec. (D.L.C.)

5460 ANGULAR DEPENDENCE OF THE SECONDARY ELECTRON EMISSION COEFFICIENT OF SINGLE-CRYSTAL SILICON IN THE RANGE OF INCIDENT ELECTRON ENERGY FROM 100 TO 2000 eV. Shul'man, A. R.; Korablev, V. V.; Morozov, Yu. A. (Polytechnic Inst., Leningrad). Sov. Phys.-Solid State (Eng. Transl.), 10: 1512-14(Dec. 1968).

Translated from Fiz. Tverd. Tela, 10: 1913-15(June 1968).

The effects of incident electron energy (E_p) from 100 to 2000 eV on the angular dependence (ϕ) of the secondary emission coefficient σ were studied for single crystals of n-type Si. The target was rotated in such a way that the electron beam was in the (110) plane, while the [111] direction issued from the surface at an angle of 2°. For E_p > 100 eV, fine structure appears in the σ vs ϕ curve; as E_p is changed, the shape of the central maximum and the angular position of the lateral maxima are changed. Curves of σ and η (inelastic reflection coefficient) vs E_p at ϕ = 0, 2, and 6° have a maximum at E_p ~ 350 eV, and ϕ-dependent fine structure also appears. A conjecture is made that the anomalous character of σ vs E_p and the fine structure of σ vs ϕ are caused by changes in the inelastic reflection of the initial electrons with E_p and ϕ. The dependence of sin α (α = angle between [111] direction and chosen minimum) on λ (de Broglie wavelength of electrons at E_p) is linear for >200 eV. (D.L.C.)

5461 SHIFT OF THE MOESSBAUER LINE OF β-Sn DURING ITS PHASE TRANSITION UNDER PRESSURE. Panyushkin, V. N. (Inst. for Physics of High Pressures, Moscow). Sov. Phys.-Solid State (Eng. Transl.), 10: 1515-16(Dec. 1968).

Translated from Fiz. Tverd. Tela, 10: 1915-17(June 1968).

The ^{119}Sn Moessbauer effect was measured in tin at pressures up to ~130 kbar, using a β-Sn foil source and a SnO_2 absorber. The energy (∂E) of the resonance line was found to decrease with pressure to -1.2×10^{-6} eV at ~110 kbar, and then to undergo a large discontinuity at the Sn I–Sn II phase transition point (~115 kbar). The discontinuity amounted to $+2.7 \times 10^{-6}$ eV; relative to the ∂E at 1 atm, the ∂E of Sn II was 1.5×10^{-6} eV. The main cause of the observed shift is the change in the ^{119}Sn isomeric shift with pressure. A qualitative explanation is made in which the Sn II phase has the $5s^25p^2$ configuration. The continuous decrease of ∂E in the 0–110 kbar region is due to the decrease of density of s electrons induced by the screening of s electrons by the 5p electrons. (D.L.C.)

5462 LOW-TEMPERATURE RADIOCRYSTALLOGRAPHIC STUDY OF THE MAGNETIC TRANSITION OF URANIUM OXIDE UO_2. de Kouchkovsky, Rostislav; Lecomte, Marcel (CEA, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 267: 620-2 (Sept. 23, 1968). (In French).

The x-ray diffraction study of the oxide UO_2 shows that the para-antiferromagnetic transition of this compound near 31°K is accompanied, from the crystallographic viewpoint, by a discontinuity of the volume alone, the symmetry remaining cubic. The transformation is reversible and is not affected by a slight deviation from stoichiometry. (tr-auth)

5463 DEEP LEVELS INTRODUCED IN THE FORBIDDEN BAND OF SILICON BY IRRADIATION WITH 300-keV ELECTRONS. Vapaille, A. (Laboratoire d'Electronique Fondamentale, Orsay, France). Ann. Phys. (Paris), 3: 5-12(Jan.-Feb. 1968). (In French).

The effects of introducing deep levels into the forbidden band of silicon, by irradiation with low-energy electrons, on two electrical properties of this material were studied: the conductivity and the lifetime of the excess carriers. Ordinary samples and epitaxial films were irradiated. Low-energy electrons are shown to introduce into the upper halfband, besides the familiar A-center level at E_c = 0.17 eV, an acceptor level at E_c = 0.13 eV; its presence could only be demonstrated in materials poor in oxygen. In the lower halfband a very deep donor center is introduced in a concentration proportional to the doping. (auth)

5464 TECHNIQUES FOR PROPER REVELATION AND VIEWING OF ETCH-TRACKS IN METEORITIC AND TERRESTRIAL MINERALS. Lal, D. (Tata Inst. of Fundamental Research, Bombay); Muralli, A. V.; Rajan, R. S.; Tamhane, A. S.; Lorin, J. C.; Pellas, P. Earth Planet. Sci. Lett., 5: 111-19 (Oct. 1968).

The revelation of fossil charged-particle tracks due to very heavy cosmic-ray nuclei (Z > 22) in meteoritic minerals and due to spontaneous fission fragments (^{238}U and ^{252}Cf) in terestrial minerals was experimentally studied. Sodium hydroxide was found to be the ideal etchant for the entire group of plagioclase feldspars and several pyroxene species. Controlled etching at 120 to 160°C reveals "proper" tracks in these minerals. The tracks formed are nearly cylindrical with sharply defined tips allowing reproducible and accurate track length measurements. A useful outcome of these experiments was the observation that controlled etching can fairly unambiguously help ascertain the position of a mineral species of a single given crystal in the solid solution series under consideration: the dispersion in etching times for normal development of known terrestrial or meteoritic mineral species is small enough (in most cases) to distinguish neighboring species. As an aid to easy and complete optical viewing of etch tracks, a concentrated blue dye solution was injected into the track holes. This considerably increases the optical contrast. Coloring of etch tracks allows reliable measurements of track lengths and easy counting of track densities in the neighborhood of 10^3 to 10^4/cm^2, as often encountered for terrestrial minerals. (auth)

5465 MOESSBAUER EFFECT IN MATERIALS SCIENCE. Gonser, U. (North American Rockwell Corp., Thousand Oaks, Calif.). Mater. Sci. Eng., 3: 1-23(May 1968).

Discussion of the major Moessbauer parameters, and a review of the current literature concerning the applications of the Moessbauer effect are given. The discussion is concerned primarily with the isotope ^{57}Fe which has had the most extensive application to materials science. A table is presented of the isotopes used in Moessbauer spectroscopy including the natural abundance, γ-ray energy, and half life of the excited state, and parent isotopes and their half life. The nuclear Zeeman effect, which has contributed significantly to the understanding of magnetic properties of all kinds of compounds, metals, and alloys, is briefly reviewed. (IAA)

5466 BERYLLIUM-VACANCY INTERACTION IN AN Al–4.4 PERCENT Zn–0.3 PERCENT Be ALLOY. Dwarakadasa, E. S.; Raman, K. S.; Vasu, K. I. (Indian Inst. of Science, Bangalore). Scr. Met., 2: 639-42(Nov. 1968).

The interaction energy between Be and vacancies was evaluated using isothermal aging of Al–4.4 at. % Zn and Al–4.4 at. % Zn–0.3 at. % Be alloys. Helixes of 0.7-mm-dia wires were quenched from 297°C and aged at 0°C and the rate of electric resistivity change followed. The results show that the presence of 0.3 at. % Be does not affect the general aging characteristics, but the rate of clustering is decreased. If an effective Zn–vacancy binding energy of 0.04 to 0.07 eV is used, a Be–vacancy binding energy of 0.11 ± 0.02 eV/atom at 0°C is obtained, comparable to that of Mg–vacancy (0.18 eV). (D.L.C.)

5467 MAGNETIC PROPERTIES OF R_4Co_3-TYPE INTERMETALLIC COMPOUNDS OF COBALT WITH RARE-EARTH METALS AND YTTRIUM. Berthet-Colominas, C. (Centre National de la Recherche Scientifique, Grenoble, France); Laforest, J.; Lemaire, R.; Pauthenet, R.; Schweizer, J. Cobalt, [17]: 97-101(June 1968).

A discussion is presented of the intermetallic compounds occurring in the various systems between RCo_2 and R_2Co. The crystal structure of R_4Co_3-type compounds, the existence of which was previously demonstrated, is examined, and the magnetic properties of isotropic compounds with gadolinium, dysprosium, holmium, erbium, and yttrium are discussed. (IAA)

5468 DIAMAGNETIC SUSCEPTIBILITY OF LANTHANUM SELENIDES. Lashkarev, G. V.; Savitskii, A. V. (Inst. for Problems of Materials, Kiev. Chernovtsy State Univ., USSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 769-770(1968). (In Russian).

The diamagnetic susceptibilities of lanthanum sesquiselenide and lanthanum diselenide were investigated in the temperature ranges 300 to 520° and 88 to 440°K, respectively. The measurements were made on powders obtained by reduction of lanthanum oxide by hydrogen selenide. The magnetic susceptibility, χ, of all samples is linearly inversely proportional to the temperature. This is evidently due to the presence of paramagnetic centers in the sample. It is most probable that admixtures of rare earth elements, which are present in the starting oxides, are also present in the compounds. The concentration of paramagnetic centers was

evaluated from the slope of the relationship $\chi = f(1/T)$ by the equation $\chi = \chi_d + \chi_p + Np_{eff}^2\mu_0/3k \cdot 1/T$ where χ_d and χ_p, not depending on temperature, are the diamagnetic susceptibility and the Van Vleck paramagnetism, respectively; N is the concentration of paramagnetic centers; μ_0 is in Bohr magnetons; p_{eff} is the effective magnetic moment of a rare earth element ion, varying from 0 for La^{3+} and Lu^{3+} to 10.6 for Dy^{3+} and Ho^{3+}. It is assumed that the orientation paramagnetism obeys the Curie law, as a consequence of the strong magnetic dilution of the paramagnetic rare earth element ions. The concentration N at $p_{eff} \approx 5$, is found equal to approximately $3 \times 10^{19}/cm^3$, which is approximately 0.3% of the rare earth element impurities with respect to lanthanum. The values of $\chi_d + \chi_p$ obtained by extrapolation of the equation to $1/T = 0$, are -135×10^{-6} cm^3/mole for lanthanum sesquiselenide, and -24×10^{-6} cm^3/mole for lanthanum diselenide, which agree well with literature data. (ATD)

5469 MAGNETIC PROPERTIES OF GADOLINIUM AND SAMARIUM SELENIDES AND TELLURIDES. Pechennikov, A. V.; Chechernikov, V. I.; Barykin, M. E.; Yarembash, E. I. (Moscow State Univ. Inst. for General and Inorganic Chemistry, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 771-2(1968). (In Russian).

The magnetic properties of Gd_2Se_3, Gd_3Se_4, $GdTe_2$, $GdTe_3$, Gd_3Te_4, $SmSe_2$, Sm_3Se_4, and Sm_2Te_3 were investigated in the temperature interval from 77 to 900°K. The measurements of the magnetic properties, both at low and high temperatures, were carried out in a vacuum of 10^{-4} mm Hg, by a method described in a previous article. It was established that the magnetic susceptibility of all the gadolinium compounds follows the Curie–Weiss law. This confirms the authors' data indicating that there exists no Van Vleck paramagnetism in gadolinium compounds. The paramagnetic Curie point for all the compounds, except Gd_3Se_4, has a negative value. The inverse magnetic susceptibility of samarium selenides and tellurides depends strongly on temperature. At first, the magnetic susceptibility decreases with a rise in temperature, and then above 400, it starts to increase again. (ATD)

5470 RANGE AND DISTRIBUTION OF IMPLANTED BORON IN SILICON. Davies, D. Eirug (Ion Physics Corp., Burlington, Mass.). Appl. Phys. Lett., 13: 243-5(Oct. 1, 1968).

The range and distribution of 200- and 400-keV boron implanted into silicon in a nonchanneling direction has been investigated by a differential capacitance method. While the range is found to correspond to that predicted from Lindhard's theory of amorphous stopping, the mean deviation does not. From the symmetry of the observed distribution, it is concluded that channeling is not responsible for the discrepancy. (auth)

5471 IMPROVED PROFILES OF ELECTRICAL ACTIVITY IN BORON-IMPLANTED SILICON. Blamires, N. G.; Matthews, M. D.; Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 28A: 178-9(Nov. 18, 1968).

A method is described for improving the electrical activity and profiles of boron implants in silicon using an auxiliary inert gas bombardment. (auth)

5472 EVIDENCE FOR A LOCALIZED MAGNETIC MOMENT IN LANTHANUM INTERMETALLIC COMPOUNDS. Toxen, A. M.; Gambino, R. J. (IBM Watson Research Center, Yorktown Heights, N. Y.). Phys. Lett., 28A: 214-15(Nov. 18, 1968).

Magnetic susceptibility measurements indicate the presence of very narrow bands or even localized moments in lanthanum intermetallic compounds having the ordered Cu_5Au structure. (auth)

5473 ENERGY BANDS AND MAGNETIC ORDERING IN TERBIUM. Mackintosh, A. R. (Technical Univ., Lyngby, Denmark). Phys. Lett., 28A: 217-18(Nov. 18, 1968).

The energy band structure of Tb has been calculated by the RAPW method. The results support the hypothesis of Keeton and Loucks concerning the relation between the Fermi surface and magnetic ordering in the hcp rare earth metals. (auth)

5474 TRANSMISSION OF A LORENTZIAN SPECTRAL LINE THROUGH A LAYER OF LORENTZIAN ABSORBERS. PART I. Heberle, Juergen (Clark Univ., Worcester, Mass. Technische Hochschule, Munich); Franco, Sergio. Z. Naturforsch., 23a: 1439-46(Oct, 1968).

The evaluation of the integral that represents the total transmitted intensity is discussed. The general case in which the thin-absorber linewidth Γ_A is allowed to be different from the linewidth Γ_S of the source is considered. The introduction of the parameter $\gamma = \Gamma_A/\Gamma_S$ has made it possible to expand the integral in an infinite series, each term of which is a rational algebraic expression. The formulation avoids the tedium of numerical integration and lends itself readily to programming in FORTRAN. The application to Moessbauer spectroscopy is discussed. The results are valid in the case of a split source even if the spacing between the emission lines is less than their linewidth. (auth)

5475 NUCLEAR MAGNETIC RESONANCE OF HOLMIUM IN A FERROMAGNETIC ALLOY. McCausland, M. A. H.; MacKenzie, I. S.; Wagg, A. R. (Univ. of Manchester, Eng.). Phys. Lett., 28A: 199-200(Nov. 18, 1968).

Spin echoes were observed at microwave frequencies in a ferromagnetic alloy of holmium and gadolinium. Seven approximately equidistant lines have been detected at frequencies which are in good agreement with the hyperfine parameters calculated by Bleaney for ^{165}Ho. (auth)

5476 CONDUCTION-ELECTRON DENSITY AT THE NUCLEUS IN Sm AND Dy METAL. Henning, W. (Technische Hochschule, Munich); Kaindl, G.; Kienle, P.; Koerner, H. J.; Kulzer, H.; Rehm, K. E.; Edelstein, N. Phys. Lett., 28A: 209-11(Nov. 11, 1968).

From Moessbauer isomer shift measurements the conduction electron densities at the nucleus in Sm metal $|\psi|^2(C.\ E.\ Sm) = (+1.4 \pm 0.4) \times 10^{26}$ cm^{-3} and in Dy metal $|\psi|^2(C.\ E.\ Dy) = (+1.65 \pm 0.35) \times 10^{26}$ cm^{-3} deduced. (auth)

5477 ASYMMETRY OF SHADOWS ARISING IN THE INTERACTION OF FAST CHARGED PARTICLES WITH SINGLE CRYSTALS. Melikov, Yu. V.; Otstavnov, Yu. D.; Puzanov, A. A.; Tulinov, A. F. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 55: 1690-5(Nov. 1968). (In Russian).

The shapes of shadows in the region of superposition of the axial [111] and linear (110) and (112) shadows produced in Coulomb scattering of 190-, 350-, and 500-keV protons on a tungsten single crystal are measured. When the linear shadow is perpendicular to the reaction plane it is found to have an asymmetric shape which changes with the distance from the center of the axial shadow. The asymmetry may be due to displacement of the source of scattered particles from the crystal lattice site. (auth)

5478 CHARGE AND HEAT TRANSFER IN YTTRIUM SINGLE CRYSTALS AT LOW TEMPERATURES. Tamarin, P. V.; Chuprikov, G. E.; Shalyt, S. S. (Inst. of Semiconductors, Moscow). Zh. Eksp. Teor. Fiz., 55: 1595-7(Nov. 1968). (In Russian).

Anisotropy of the electric and thermal conductivities (σ,$\varkappa$) and of the thermal emf (α) of pure yttrium single crystals is investigated at low temperatures. Between 300 and 3°K the anisotropy of σ varies between 2.2 and 3.9 and the anisotropy of α between 1.5 and 0.5. With decreasing temperature the anisotropy of $\varkappa$ increases and is maximal at 10°K. (auth)

5479 OBSERVATION OF PENDELLOESUNG FRINGE STRUCTURE IN NEUTRON DIFFRACTION. Shull, C. G. (Brookhaven National Lab., Upton, N. Y. Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 21: 1585-93(Dec. 2, 1968).

Observations are reported on the appearance of Pendelloesung interference fringes within neutron Bragg reflections. These have been used to determine the atomic scattering amplitude of silicon for neutrons as $(0.41646 \pm 0.00022) \times 10^{-12}$ cm. Conclusions are drawn concerning the spatial extent of the neutron wave packet from the fringe characteristics. (auth)

5480 FERMI SURFACES FOR dhcp La, Nd, AND Pr: RELATIONSHIP TO MAGNETIC ORDERING AND CRYSTAL STRUCTURE. Fleming, G. S.; Liu, S. H.; Loucks, T. L. (Ames Lab., Iowa). Phys. Rev. Lett., 21: 1524-6(Nov. 25, 1968).

The calculation of the relativistic energy bands and Fermi surfaces of the double hexagonal close-packed light rare-earth elements lanthanum, neodymium, and praseodymium is reported. The relationship of the Fermi surface to the ordering of magnetic moments in Nd and Pr and to the occurrence of the double hexagonal closed-packed crystal structure is then discussed. (auth)

5481 NEW METHOD OF RESOLVING NMR STRUCTURES USING DYNAMIC NUCLEAR POLARIZATION TECHNIQUES. Lee, Sook (St. Louis Univ.). Phys. Rev. Lett., 21: 1627-9 (Dec. 9, 1968).

A new method is presented of resolving NMR structures in solids using dynamic nuclear polarization (the solid-state effect) methods. It is shown that NMR quadrupole and/or dipole structures completely unresolved in thermal-equilibrium NMR spectra can be resolved under dynamic nuclear polarization produced by saturating the center of an inhomogeneously broadened ESR line. (auth)

5482 GENERALIZED SUSCEPTIBILITIES AND MAGNETIC ORDERING OF HEAVY RARE EARTHS. Evenson, William Edwin. Contract W-7405-eng-82. Ames, Iowa, Iowa State Univ., 1968. 93p. (IS-T-226).

Thesis.

Within the framework of Ruderman–Kittel–Kasuya–Yoshida indirect-exchange interaction theory, the generalized susceptibil-

ities, $\chi(q)$, have been calculated for the heavy rare-earth metals, Gd, Dy, Er, and Lu, along the line Γ to A of the Brillouin zone. The energy bands used in this calculation were realistic bands obtained by Keeton and Loucks using the relativistic-augmented-plane-wave method. The matrix elements involved in the susceptibilities were taken to be constants so that the susceptibilities calculated contain only information from the energy bands. To develop a reliable numerical procedure, two sets of energy bands were examined in detail which could be calculated analytically as well as numerically. These bands were chosen to give spherical and cubic Fermi surfaces. The results obtained from them showed how to eliminate any spurious features in the susceptibilities arising from the numerical calculation, and once these spurious features were removed these special bands demonstrated that the numerical procedures were quite reliable. Cubic and spherical Fermi surfaces were chosen because they illustrate two extremes in the features of the susceptibilities: the cubic surface has many points separated by the same wave vector, Q, so there is "nesting" of areas of the Fermi surface for q = Q; the spherical surface has only point to point nesting for any particular q. The nesting of areas results in a logarithmic divergence in the susceptibility, whereas the nesting of lines or points results only in a general falling off of the susceptibility. This fact is clearly illustrated in the two special cases. It is also possible to relate the features of the susceptibilities calculated for the rare earths to the geometries of their Fermi surfaces in the same way. This was done and the maxima of the calculated susceptibilities related to the magnetic ordering periodicity observed experimentally for each of the metals considered. The agreement between theory and experiment was found to be quite satisfactory. (Disser. Abstr.)

5483 ANOMALOUS HYPERFINE FIELDS DETECTED WITH THE DIFFERENTIAL ANGULAR CORRELATION METHOD. Klepper, O.; Spehl, H.; Wertz, N. (Univ., Freiburg i. B.). Z. Phys., 217: 425-37(1968).

Time differential perturbed angular distributions of nanosecond levels of some rare-earth nuclei embedded in a ferromagnetic host lattice were measured. Coulomb excitation with 4 to 10-MeV α particles and recoil implantation technique were used. Some evidence was found for anomalous hyperfine fields acting on the nucleus in a time period which can not be resolved. On a time scale starting at about 1 nsec where details can be resolved, the hypothesis of a static hyperfine field parallel to the external polarizing field seems to be justified. (auth)

5484 MEASUREMENT OF THE ACTIVATION ENERGIES OF THE DISLOCATION ANCHORING IN COPPER AFTER ELECTRON IRRADIATION AT 78°K. Roth, G.; Naundorf, V. Phys. Status Solidi, 29: K123-5(Oct. 1, 1968). (In German).

Polycrystalline Cu of 99.999% purity was irradiated at 78°K with 3-MeV electrons up to doses of 3×10^{13} electrons/cm^2. The dislocation anchoring produced by the radioinduced defects was followed on the basis of E modulus measurements. In addition to a slight anchoring occurring during irradiation, four other anchoring stages were observed. The activation energies of the four stages were measured according to the relation $\Delta T/T_{max} = 2.5\ kt_{max}/U$ from the half value widths ΔT and the maxium temperature T_{max} of the differentiated recovery curve and by the temperature change method from isothermal measurements at temperatures separated from each other by 15°K. The values obtained by the two methods are tabulated and compared with each other. The results showed that in order to observe the various stages, the defect concentration produced in the lattice must most exceed a value of 10^{-9}. The dislocation anchoring was in the same temperature regions as the recovery of the electrical resistance. Stage III of the dislocation anchoring is in the temperature range in which dislocation anchoring was previously found after quenching. (J.S.R.)

5485 TRANSITION RADIATION FOR OBLIQUE ELECTRON INCIDENCE WITH CONSIDERATION OF PLASMA WAVES. Forstmann, Frank (Univ., Cologne). Z. Phys., 217: 416-24 (1968). (In German).

The transition radiation emitted from an electron-bombarded metal surface is calculated for oblique electron incidence. The excitation of plasma waves is taken into account explicitly. This leads to a change in the radiation intensities of 25% near the plasma frequency, compared with calculations without spatial dispersion by Boersch et al. (auth)

5486 HIGH FIELD MAGNETIZATION OF THULIUM SINGLE CRYSTALS. Richards, Durkee Benham. Contract W-7405-eng-82. Ames, Iowa, Iowa State Univ., 1968. 75p. (IS-T-220).

Thesis.

A magnetometer was designed and constructed to be used in a 1.01-inch-bore superconducting solenoid wound with Nb_3Sn ribbon. It is of the vibrating sample type and uses a null method in which the signal from the sample pickup coils is nulled out with a reference signal generated by a transducer on the sample rod. A bridge circuit is used to allow nulling the in-phase and quadrature components separately. With this magnetometer, the magnetization of thulium was measured along the $\langle 10\bar{1}0 \rangle$ and c-axis directions from 4.2 to 300°K and in magnetic fields up to 100 kOe. Low-field isofields for both directions indicate a Néel temperature of 58°K. The isotherms for both directions below 58°K show a large anisotropy favoring the c-axis, and suggest that the antiferromagnetic structure below 58°K is an axial structure oriented along the c-axis. The low-field isofield for the c-axis shows that at about 42°K the antiferromagnetic structure begins to square up, and at about 25°K has become a ferrimagnetic structure with a net moment along the c-axis at 4.2°K of 1.0 μ_B per atom. The ferrimagnetic coupling can be overcome by magnetic fields above 28 kOe yielding a ferromagnetic structure with a saturation magnetization of 7.14 μ_B per atom at 4.2°K. The $\langle 10\bar{1}0 \rangle$ direction, however, remained magnetically hard to the highest fields used; at 4.2°K the moment reached 0.75 μ_B per atom at 93 kOe. From plots of $1/\chi_g$ vs T, the value for μ_{eff} was found to be 7.61 μ_B. Extrapolating these plots to the temperature axis gave values for the paramagnetic Curie temperatures of $\theta_{||} = 41$°K and $\theta_{\perp} = -17$°K, where $\theta_{||}$ is for fields applied along the c-axis, and $\theta_{\perp}$ is for fields applied perpendicular to the c-axis. The difference between these values is interpreted in terms of the large axial anisotropy of thulium. (Diss. Abstr.)

5487 THE MAGNETIC PROPERTIES OF d^1 TRANSITION METALS. Wohlleben, Dieter Karl. San Diego, Calif., Univ. of California, 1968. 176p.

Thesis.

Measurements are reported of the susceptibility of pure Sc, Y, and La and of dilute alloys of nonmagnetic metals with Sc between 0.36 and 300°K. The susceptibility of Sc is 15% larger than previously reported. It is very sensitive to a reduction by nonmagnetic heavy impurities via spin–orbit coupling. This interaction is also effective in reducing the susceptibility of pure polycrystalline Sc and Y with respect to the single crystal. The susceptibility of pure polycrystalline La is abnormal because it does not show the parabolic temperature dependence expected from Fermi statistics down to 2°K. The saturation moment of Gd ions dissolved in Sc and Y at extreme dilution (100 ppM) was also studied. It is more than 9.9 μ_B in Sc and 7.6 μ_B in Y. This enhancement is contrasted to the decrease of the moment on Gd in Pd. The polarization is on the d shells, and the reversal of sign is a consequence of the electron–hole symmetry of Pd and Sc. The interaction of dilute Gd impurities in Sc is about six times stronger than in La. The abnormal behavior of the Néel temperature of dilute rare earth impurities in Sc and Y is interpreted as the result of a long-range impurity interaction through the d shells of these metals, which is oscillatory with the lattice period and is not related to the Ruderman–Kittel interaction. It is suggested that critical spin fluctuations exist in Sc which correspond to the thermal spin fluctuations above the Néel temperature of an antiferromagnet. (Diss. Abstr.)

5488 CRYSTAL GROWTH IN GELS. Dennis, James Carl. University Park, Pa., Pennsylvania State Univ., 1967. 98p.

Thesis.

A method is described which permits certain types of single crystals to be grown in silica gels. The technique is of special value for substances which by virtue of their low solubilities of low dissociation temperatures cannot readily be grown in other ways. It can yield large crystals (e.g., up to 11 mm) of high optical quality, doped or undoped. Most of the results refer explicitly to the insoluble iodides and tartrates, but a great variety of other crystals have been prepared. The nucleation rate and the uptake of impurities from the gel are found to be functions of the irradiation intensity and dosage. Existing theories are tested which apply specifically to crystal growth in stagnant solutions by means of gel systems. Because the crystals in any one growth system grow competitively, nucleation control is one of the keys to practical exploitation of the gel-growth technique. This thesis discusses some of the principal factors on which nucleation in gels depends and shows how nucleation can be controlled by concentration programming, by trace impurities, and by varying the gel structure. Multiple re-seeding procedures are described which permit the growth of larger crystals than can be obtained with single stages. (Diss. Abstr.)

5489 THE LOW-TEMPERATURE SPECIFIC HEAT OF SOME CERIUM AND LANTHANUM LAVES-PHASE COMPOUNDS. Joseph, Robert Roderick. Contract W-7405-eng-82. Ames, Iowa, Iowa State Univ., 1968. 78p. (IS-T-228).

Thesis.

The low-temperature specific heats of the Laves-phase intermetallic compounds $CePt_2$, $CeRu_2$, $LaPt_2$ and $LaRu_2$ were measured between 1.4°K and 8°K and in fields up to 9.0 kOe. $CeRu_2$ and $LaRu_2$ were determined to be type II superconductors with transition tem-

peratures of 5.92°K and 3.20°K, respectively. The magnetic susceptibility as well as the specific heat of $CePt_2$ indicate that it orders magnetically at 1.7°K. The cerium atom in $CePt_2$ appears to be trivalent in the paramagnetic region. The data on $LaPt_2$ indicate that it behaves like a normal metal with a specific heat comparable to pure copper. The Debye temperatures of the compounds have been correlated with the radius ratios of the component metals. Techniques have been developed to prepare these peritectically melting compounds in single-phase form suitable for calorimetric measurements. The lattice parameters of pseudo-binary system $CePt_{2-x}Ru_x$ are presented, as well as some observation on the phases present. (Diss. Abstr.)

5490 RESONANCE AND RELAXATION OF FLUORINES IN POWDERS OF URANIUM(VI) COMPLEX FLUORIDES. Dianoux, A. J.; Rigny, P. (Centre d'Etudes Nucleaires, Saclay, France). J. Phys. (Paris), 29: 791-8(Aug.-Sept. 1968). (In French).

A ^{19}F magnetic resonance absorption and relaxation study in the complex fluorides $NaUF_7$ and Na_2UF_8 is presented. The results show the existence of large and anisotropic chemical shift tensors, and a structural model is proposed. Thus in $NaUF_7$, six fluorine atoms would be bonded by covalence to the uranium, and this octahedron would undergo rotations having 0.46 eV activation energy. In Na_2UF_8, no definite structural model could be put forward; however the very symmetrical structure proposed by Malm et al. seems to be ruled out. (auth)

5491 ^{27}Al NUCLEAR MAGNETIC RESONANCE STUDIES IN SOLUTIONS OF LIGHT AND HEAVY WATER AND THE RATIO OF THE LARMOR-FREQUENCIES OF ^{27}Al AND ^{2}H. Epperlein, B. W.; Lutz, O. (Univ., Tuebingen, Ger.). Z. Naturforsch., 23a: 1413-14(Sept. 1968).

The Larmor frequency and NMR were measured for $AlCl_3$ and $Al(NO_3)_3$ in H_2O and D_2O, and $Al_2(SO_4)_3$ in H_2O. A chemical shift, dependent on salt concentration, was found for the ^{27}Al resonance in $Al(NO_3)_3$ in H_2O. The difference in the ^{27}Al Larmor frequency in H_2O and D_2O is: $\nu(H_2O) - \nu(D_2O) = 5 \pm 1$ Hz. The D resonance is dependent on the salt concentration, its linewidth increasing with concentration. The ratio of the Larmor frequencies of ^{27}Al and D is extrapolated to be $\nu^{27}Al/\nu_D = 1.69744096$ at zero concentration. The magnetic moment of ^{27}Al, as the heavy water-hydrated Al^{3+} ion, is calculated to be (uncorrected for electron diamagnetism) $+3.6384084\ \mu_N$. (D.L.C.)

5492 ELECTRON PARAMAGNETIC RESONANCE IN IRRADIATED Ag_2CO_3. Ashford, Nicholas A.; Noble, Gordon A. (IIT Research Inst., Chicago). J. Chem. Phys., 49: 4720-1 (Nov. 15, 1968).

Gamma irradiation of Ag_2CO_3 at liquid nitrogen temperature resulted in the production of at least two and perhaps three paramagnetic species. Part of the EPR spectra can be interpreted with reasonable certainty to be due to NO_2 introduced in preparation. One paramagnetic species is thought to be a localized electron. The third is unidentified. Several species observed in related materials, Ag^0, Ag^{2+}, CO_3^-, CO_3^{3-}, and Co_3^-, were not observed. (A.G.W.)

5493 SPECTRA AND ENERGY LEVELS OF RARE EARTH IONS IN CRYSTALS. Dieke, Gerhard Heinrich. New York, John Wiley and Sons, Inc., 1968. 409p.

A summary is presented of knowledge on the problem of the electronic structure of the low $4f^N$ levels of the rare earths, as deduced from studies of the optical spectra of crystals. Topics covered by the 14 chapters include: crystal field; crystal symmetry and structure of the spectrum; intensities, selection, and polarization rules; Zeeman effect and magnetic properties; divalent rare earth ions in crystals; review of empirical data; and line structure. An extensive bibliography and author and subject indexes are included. (D.L.C.)

Theoretical Physics

Refer also to abstracts 5375, 5757–5759, and 5976.

5494 (NYO-1480-83(Pt.2)) TECHNICAL SUMMARY: TASK V. Progress Report No. 38A, July 1–December 31, 1966. (New York Univ., N. Y. AEC Computing and Applied Mathematics Center). Nov. 29, 1967. 17p. Dep. CFSTI.

COMPUTERS—activities at New York University
FLUID FLOW—calculations in
FLUIDS—calculations for classical and quantum
MATHEMATICS—computational activities at New York University
QUANTUM MECHANICS—calculations in (D.L.C.)

5495 (NYO-1480-83(Pt.3)) TECHNICAL SUMMARY: TASK V. Progress Report No. 38B, January 1–June 30, 1967. (New York Univ., N. Y. AEC Computing and Applied Mathematics Center). Nov. 29, 1967. 30p. Dep. CFSTI.

COMPUTERS—activation at New York University
FLUID FLOW—calculations in
FLUIDS—calculations for classical and quantum
MATHEMATICS—computational activities at New York University
QUANTUM MECHANICS—calculations in (D.L.C.)

5496 (UCSD-10-P-11-82) RELATIVISTIC THERMODYNAMICS. van Kampen, N. G. (California Univ., La Jolla, San Diego). Aug. 2, 1968. Contract AT(11-1)-Gen-10. 19p. (CONF-680928-1). Dep. CFSTI.

From Conference on Statistical Mechanics, Kyoto, Japan.

The difference of opinions on the application of the special theory of relativity to thermodynamics is pointed out. The problem is to extend thermodynamics to systems whose velocity can be varied, in such a way that the quantities (T, S, E, dQ, dA) reduce to the familiar ones for zero velocity, they retain their physical meaning, and the laws of thermodynamics remain valid. The specification of the system is considered, and the effect of the wall of the containing vessel (self-contained) is pointed out. Equations are derived for the thermodynamics of self-contained systems in motion. Heterotachic processes (direct transfer of energy between systems with different velocities) are studied. Finally, the statistical mechanics aspect is discussed. (D.L.C.)

5497 ONE- AND TWO-DIMENSIONAL GREEN'S FUNCTIONS FOR ELECTROMAGNETIC WAVES IN MOVING SIMPLE MEDIA. Compton, R. T. Jr. (Technische Hochschule, Munich). J. Math. Phys. (N. Y.), 9: 1865-72(Nov. 1968).

The one- and two-dimensional Green's functions associated with electromagnetic radiation in a moving medium are considered. The medium is assumed to be lossless, to have constant permittivity and permeability, and to move with constant velocity with respect to a given inertial coordinate system. For each source (line source or plane source) both the time-dependent and the harmonic Green's functions are found. The results are obtained by means of special transformations which convert the equations to be solved into standard forms. The significance of the results, in terms of one- and two-dimensional Cherenkov radiation, is discussed. (auth)

5498 QUANTUM THEORY AND STATISTICAL PHYSICS. Barut, Asim O.; Brittin, Wesley E. (eds.). Lectures in Theoretical Physics. Volume X-A. New York, Gordon and Breach, Science Publishers, 1968. 581p. $21.50 cloth; $14.50 paper.

Twelve lectures are included; separate abstracts were prepared for eight. Lectures not abstracted for NSA deal with interactions in relativistic classical particle mechanics, functional integrals in Brownian motion; nonequilibrium statistical mechanics; and nonlinear rate equations. (L.B.S.)

For abstracts of individual papers see: 5500, 5597, 5652, 5672–5674, 5698, and 5701.

5499 NEW FORMULATION OF STOCHASTIC THEORY AND QUANTUM MECHANICS. de la Pena-Auerbach, L. (Univ. Nacional de Mexico, Mexico City). Phys. Lett., 27A: 594-5 (Sept. 23, 1968).

A new formulation of stochastic theory is given by a generalization of Newtonian mechanics, and from this Schrödinger's equation emerges in a natural way. Non-Markovian terms may be important for possible extensions. (auth)

5500 DIAGRAM METHOD FOR THE DENSITY MATRICES. Isihara, A. (State Univ. of New York, Buffalo). pp 329-50 of Quantum Theory and Statistical Physics. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

Some quantum field theoretical methods for the density matrices or distribution functions are discussed. The topics covered include the propagator formalism, linked cluster expansion, Boltzmann chains, electron gas, hard-sphere Boltzmann gas, hard-sphere Bose gas, and hard-sphere Fermi gas. (L.B.S.)

5501 QUANTUM MECHANICS AS A BROKEN SYMMETRY. Kastrup, H. A. (Univ., Munich). Nucl. Phys., B7: 574-82(1968).

The algebra of quantum mechanics is derived by breaking the exact Liouville symmetry of free nonrelativistic stationary systems. The Liouville group consists in this case of the Euclidean group, the dilatations and the three-parameter special Liouville group. The two latter groups induce global and local geometrical gauge transformations. The dilatations imply continuous energy spectra, and therefore they have to be broken if we want to allow for the frequent discrete energy spectra in atomic physics, etc. Since physical states are represented by rays rather than vectors,

it is sufficient to contract the dilatations into a phase transformation. These physical conditions on the breaking of the dilatations for interacting systems imply that the generators of the special Liouville group go over into multiples of the usual position operators. (auth)

5502 TRACES OF PRODUCTS OF ANGULAR MOMENTUM MATRICES. Dalton, N. W. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 28A: 172-3(Nov. 18, 1968).

A new computer-orientated method is proposed for evaluating the traces of products of angular momentum matrices. (auth)

5503 SONIC EXCITATION OF A SUPERRADIATIVE ELECTROMAGNETIC STATE IN MATTER. Alekseev, A. V.; Kopvillem, U. Kh.; Nagibarov, V. R.; Pirozhkov, M. I. (Physical-Technical Inst., Alma-Alta, USSR). Zh. Eksp. Teor. Fiz., 55: 1852-63(Nov. 1968). (In Russian).

The possibility of generating pulsed coherent physical fields at the expense of other coherent fields is investigated when the field frequencies are equal or multiples but their wave vectors are very different. It is shown that if the duration of the excited pulses and the interval between them does not exceed the phase memory time of the active particles of the working substance of the generator, the phase memory effects may "efface" the difference between the wave vectors of the exciting and generated fields. This new principle of transformation of wave vectors in echo signals is applied to the problem of excitation of electromagnetic waves by ultrasound. For this purpose nuclear and electron spin systems can be transferred into a superradiative electromagnetic state by sound pulses. An experimental realization of these ideas should raise the method of magnetic quantum acoustics to the level of the electromagnetic spin echo technique and as far as obtaining information on the structure and dynamics of matter is concerned it should be considerably superior to the usual spin echo method. (auth)

5504 DIAGRAM TECHNIQUE NEAR THE CURIE POINT AND THE PHASE TRANSITION OF THE SECOND KIND IN A BOSE FLUID. Migdal, A. A. Zh. Eksp. Teor. Fiz., 55: 1964-79(Nov. 1968). (In Russian).

The behavior of a bose fluid on approach to the phase transition curve from the normal phase side is considered by aid of the temperature Green functions. A method of renormalization of the diagram is proposed which permits one to determine for all quantities the dependence on the distance ξ from the phase curve. It is proven that the zero frequency Green functions determining the static properties of the system and the features of thermodynamic quantities are universal homogeneous functions of the momenta and ξ. For example, the momentum distribution of particles (one-particle Green function) has the form $n(p) = \xi^{-\alpha} g(p/\xi^{\beta})$. The exponents of ξ in the correlation and thermodynamic functions (critical indices) can be expressed in terms of α and β. The function $g(x)$ and numbers α and β are related in a simple manner to the renormalized phonon emission vertex, the equation of which does not contain any parameters and which, in principle, can be solved numerically. Various asymptotic values of the Green functions are investigated. It is shown how these methods can be extended to the case of an arbitrary system near the phase curve by means of the unitarity and analyticity relations which are exactly the same as those in the theory of relativistic particles with a rest mass $M = \xi^{\beta}$. (auth)

5505 WAVE FUNCTIONS OF CONDENSED STATES. Mestechkin, M. M. (Inst. of Physical Chemistry, Kiev). Zh. Eksp. Teor. Fiz., 55: 2003-10(Nov. 1968). (In Russian).

An extreme type wave function for an N-fermion system is constructed. The eigenvalue of the s-order reduced density matrix for this function is, in the limit of an infinite rank, equal to $\binom{p}{n}$ where $n = N/\alpha$ and $p = s/\alpha$, α being an even number of fermions in a minimal group subjected to off-diagonal, long-range correlations. In general, the density matrix eigenvalues increases when all groups of α fermions enter the wave function of the whole system in a more symmetrical way. (auth)

5506 THEORY OF FERMI–BOSE QUANTUM FLUIDS. Khalatnikov, I. M. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz., 55: 1919-31(Nov. 1968). (In Russian).

A formulation of a phenomenological theory of Fermi and Bose fluid mixtures (fermi-bose fluids) is presented which is similar to that of Landau for Fermi fluids. A definition of the Fermi excitation energy in a superfluid liquid is given. An exact equation set describing the properties of a Fermi-Bose liquid is obtained. Acoustic solutions of the set are analyzed. (auth)

5507 PROBLEME A N CORPS. (Many-Body Physics). DeWitt, Cecile; Balian, Roger (eds.). Many-Body Physics 1967 Lecture Notes of the Les Houches Summer School. New York, Gordon and Breach Science Publishers, Inc., 1968. 441p. $14.50 Hardbound; $9.50 Paperback. (In French and English).

Separate abstracts were prepared for 2 of the papers concerned with theories of superconductors and superfluids. (M.O.W.)

For abstracts of individual papers see: 5360 and 5361.

5508 ON STOCHASTIC THEORIES OF QUANTUM MECHANICS. Gilson, J. G. (Queen Mary Coll., London). Proc. Cambridge Phil. Soc., 64: 1061-70(Oct. 1968).

The theory of stochastic processes is a comprehensive theory concerning the time development of probabilistic systems, and quantum mechanics as described by the Schroedinger equation depends heavily on probabilistic interpretation, although it is not clear how it is related to stochastic theory. A great difference between the stochastic theory and quantum mechanics is that whereas in the former probabilities are superposed, in quantum mechanics amplitudes or wave functions are superposed. Reference is made to the study of these problems by Moyal (Proc. Camb. Phil. Soc., 45: 99-124(1949)), using an analysis involving quantum phase change distributions, and also involving the question of determinism in quantum systems (not always, however, in the classical sense). Some features of the problems are analyzed in the light of whether or not quantum mechanics is a real stochastic process and not just formal, using the Feynman integral. It is seen that this integral when suitably employed gives a structure which can easily be compared with standard stochastic methods in configuration space. The study is concerned with comparing some stochastic theories with the conventional use of the Schroedinger equation where a real potential function is employed. (UK)

5509 POSITION OPERATORS OF QUANTUM SYSTEMS DESCRIBED BY FINITE- AND INFINITE-DIMENSIONAL WAVE EQUATIONS. Malin, Shimon. Boulder, Colo., Univ. of Colorado, 1968. 95p.

Thesis.

A new consistency requirement concerning position operators in quantum mechanics is introduced: It is shown that the definition of position operator uniquely determines an expression for the probability density. A definition of a position operator is, therefore, acceptable only if this uniquely determined expression is a fourth component of a four-vector which, moreover, satisfies together with the other three components a continuity equation. It is proved that the Dirac theory satisfies this requirement. It is further proved that it is impossible to define consistently a position operator for a Klein–Gordon particle. Other quantum systems described by finite dimensional wave equations are discussed. A theory of a spin-0 particle which is a bound state of two Dirac particles in the limit of weak binding is introduced and the center-of-mass probability density and current are found to be, in general, different from the corresponding Klein–Gordon expressions. The properties of position operators of quantum systems described by infinite-dimensional wave equations are investigated. In particular, the analogue of the Foldy–Wouthuysen transformation is introduced and used to calculate the range of zitterbewegung for particles described by the Majorana equation and by equations based on representations of the noncompact group 0(4,2). The results indicate a strong connection between the properties of the position operator and the internal structure of the corresponding quantum systems. (Diss. Abstr.)

5510 STABILITY OF MATTER. Dyson, F. J. (Inst. of Advanced Study, Princeton, N. J.). pp 179-239 of Statistical Physics, Phase Transitions, and Superfluidity. Vol. I. Chretien, M.; Gross, E. P.; Deser, S. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

Theorems are developed for the stability of a system of point charges, positive and negative, interacting purely through Coulomb forces and obeying the laws of nonrelativistic quantum mechanics. (M.O.W.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 5550 and 5719.

Electromagnetic

Refer also to abstracts 5539 and 5560.

5511 (NP–17682) SINGLE-NEGATIVE-PION PHOTOPRODUCTION ON DEUTERIUM IN THE ENERGY RANGE (500 + 800) MeV: PRELIMINARY RESULTS. Note No. 182. Beneventano, M.; de Notaristefani, F.; Monacelli, P.; Paoluzi, L.; Sebastiani, F.; Severi, M. (Rome Univ. (Italy). Istituto di Fisica). July 24, 1968. 9p. Dep.

Preliminary results of measurements at the 1.1 GeV Frascati electron-synchrotron of the differential cross section of the single π^- photoproduction on deuterium $\gamma + n \rightarrow p + \pi^-$ for $(\Theta_\pi)_{CM} = 90°$ and in the incident γ ray energy range of 500 to 800 MeV are reported. The experiment has been designed to add data in the rather poor energy region between the first and the second resonance. (auth)

5512 (SLAC-PUB-502) ELECTROMAGNETIC INTERACTIONS: LOW q^2 ELECTRODYNAMICS: ELASTIC AND INELASTIC ELECTRON (AND MUON) SCATTERING. Panofsky, W. K. H. (Stanford Linear Accelerator Center, Calif.). Sept. 1968. 61p. (CONF-680809–37). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

A discussion of quantum electrodynamics at low momentum transfers is presented, including the discrepancies on the fine structure constant, the Lamb shift, and g factors of the electron and muon. Elastic electron–nucleon and muon–nucleon scattering are discussed with emphasis on the electron–muon equality. Information from experiments on inelastic scattering of electrons by nucleons relevant to T violation, pion form factor, form factors of specific resonant states and extrapolation of inelastic electron scattering to zero momentum transfer yielding the total photon absorption cross sections, and excitation of the nucleon into the continuum are reviewed. 46 references. (C.E.S.)

5513 ELECTROPRODUCTION OF PIONS NEAR THE Δ(1236) ISOBAR AND THE FORM FACTOR $G_M^*(q^2)$ OF THE $(\gamma N\Delta)$-VERTEX. Bartel, W.; Dudelzak, B.; Krehbiel, H.; McElroy, J.; Meyer-Berkhout, U.; Schmidt, W.; Walther, V.; Weber, G. (Deutsches Elektronen-Synchrotron, Hamburg. Univ., Hamburg). Phys. Lett., 28B: 148-51(Nov. 11, 1968).

The cross section for inelastic electron–proton scattering was measured at incident electron energies of 1.5 to 6 GeV by magnetic analysis of the scattered electrons at angles between 10° and 35°. For invariant masses of the hadronic final state $W \leq 1.4$ GeV, the measured spectra are compared with theoretical predictions for electroproduction of the Δ(1236) isobar. The magnetic dipole transition form factor $G_M^*(q^2)$ of the $(\gamma N\Delta)$-vertex is derived for momentum transfers $q^2 = 0.2–2.34$ $(GeV/c)^2$ and found to decrease more rapidly with q^2 than the proton form factors. (auth)

5514 PION PRODUCTION WITH POLARIZED PHOTONS AND TEST OF VECTOR DOMINANCE MODEL. Geweniger, Chr.; Heide, P.; Koetz, U.; Lewis, R. A.; Schmueser, P.; Skronn, H. J.; Wahl, H.; Wegener, K. (Deutsches Elektronen-Synchrotron, Hamburg. Univ., Hamburg). Phys. Lett., 28B: 155–6(Nov. 11, 1968).

Cross section asymmetries for the sum of single π^+ and π^- production with polarized photons of 3.4 GeV were measured. The results disagree with calculations based on the vector dominance model using experimental data of vector meson production in π beams. (auth)

5515 HISTORY OF THE POSITRON. Sharrock, S. J. (University Coll., London). Phys. Bull. (London), 19: 380–4 (Nov. 1968).

A review is given including the following headings: a new charged particle; Dirac's theory of the electron; measurements from cloud chamber photographs; Anderson's experiments on cosmic rays; Blackett's experiments on cosmic rays. (UK)

5516 SUBTRACTION CONSTANTS IN DISPERSION RELATIONS FOR COMPTON SCATTERING AND VECTOR-MESON DOMINANCE. Walker, James K. (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett., 21: 1618-20(Dec. 2, 1968).

The requirement of a subtraction constant at infinite energy for the real part of the forward spin-nonflip Compton scattering amplitude from a proton is discussed, and an upper limit 6.3×10^{-4} F/BeV^2 for such a constant is obtained. It is shown that the model of vector dominance applied to Compton scattering at 3-BeV photon energy is consistent with known photon total cross sections and the application of forward-scattering dispersion relations. (auth)

5517 PARTIAL PHOTOPRODUCTION CROSS SECTIONS P TO 12 GeV. Ballam, J.; Chadwick, G. B.; Guiragossian, Z. G. T.; Klein, P.; Levy, A.; Menke, M.; Pickup, E.; Tan, T. H.; Seyboth, P.; Wolf, G. (Stanford Linear Accelerator Center, Calif.). Phys. Rev. Lett., 21: 1541-4(Nov. 25, 1968).

The Stanford Linear Accelerator Center 40-in. hydrogen bubble chamber has been exposed to positron-electron annihilation radiation at 5 and 7.5 GeV, which was superimposed upon a background of bremsstrahlung radiation with 12-GeV maximum energy. Reaction cross sections for events with no neutral particles are presented for all energies up to 12 GeV, for one neutral at 5 and 7.5 GeV, and for multineutral production at 7.5 GeV. (auth)

5518 γ-p TOTAL HADRONIC CROSS SECTIONS AT 7.5 GeV. Ballam, J.; Chadwick, G. B.; Guiragossian, Z. G. T.; Klein P.; Levy, A.; Menke, M.; Pickup, E.; Seyboth, P.; Tan, T. H.; Wolf, G. (Stanford Linear Accelerator Center, Calif.). Phys. Rev. Lett., 21: 1544-7(Nov. 25, 1968).

The total hadronic γp cross section has been measured using 7.5-GeV positron-electron annihilation radiation in a hydrogen bubble chamber. A value of 126 ± 17 μb is found, excluding reactions with only one charged particle (~3 μb). (auth)

5519 METHOD OF MEASURING THE BETA-DECAY COUPLING CONSTANT OF THE RHO MESON. Roe, Byron P. (CERN, Geneva). Phys. Rev. Lett., 21: 1666-9(Dec. 9, 1968).

It is proposed that one measure the diffraction production of the ρ meson by high-energy neutrinos, i.e., the process $\nu \rightarrow \mu^- + \rho_{virtual}^+$ followed by ρ^+ diffraction scattering. By comparison with $\gamma + p \rightarrow \rho^0 + p$, the β-decay coupling constant can then be obtained. The process is distinguishable experimentally because of the characteristic low momentum transfer to the nucleon. Numerical calculations indicate that this process should be observable in large heavy-liquid bubble chambers. (auth)

5520 ELECTROMAGNETIC DECAY OF THE $Y_0^*(1520)$. Mast, Terry S.; Alston-Garnjost, Margaret; Bangerter, Roger O.; Barbaro-Galtieri, Angela; Gershwin, Lawrence K.; Solmitz, Frank T.; Tripp, Robert D. (Univ. of California, Berkeley). Phys. Rev. Lett., 21: 1715-17(Dec. 16, 1968).

The decay of the $Y_0^*(1520) \rightarrow \Lambda + \gamma$ has been discovered in the reaction $K^- + p \rightarrow \Lambda +$ neutrals. The angular distribution and polarization of the Λ are consistent with a pure electric dipole transition. The cross section yields a partial width for the decay of 0.15 ± 0.03 MeV. (auth)

5521 PHOTOPRODUCTION OF MESON AND BARYON RESONANCES AT ENERGIES UP TO 5.8 GeV. Erbe, R. (Technische Hochschule, Aachen); Hilpert, H. G.; Schuettler, E.; (and others). Phys. Rev., 175: 1669–96(Nov. 25, 1968).

In a study of photoproduction at photon energies between 0.3 and 5.8 GeV in a hydrogen bubble chamber, approximately 31,000 events with three, five, or seven outgoing charged particles were analyzed. A survey is given of the experimental procedure and of resonance production in quasi-two-body reactions. The cross sections for the processes $\gamma p \rightarrow p\pi^+\pi^-$, $\gamma p \rightarrow p\pi^+\pi^+\pi^-\pi^-$, $\gamma p \rightarrow p\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-$, $\gamma p \rightarrow pV(V = \rho^0, \omega, \phi)$, $\gamma p \rightarrow p\eta$, $\gamma p \rightarrow pX^0$, $\gamma p \rightarrow \Delta^{++}\pi^-$, and $\gamma p \rightarrow \Delta^0\pi^+$ were measured as a function of the photon energy. For reactions $\gamma p \rightarrow p\rho^0$, $\gamma p \rightarrow p\omega$, and $\gamma p \rightarrow \Delta^{++}\pi^-$, the differential cross sections and density matrix elements are given for various intervals of the photon energy. The photoproduction of vector mesons and Δ isobars is discussed in terms of several models. (auth)

Weak

Refer also to abstracts 5515 and 5804.

5522 ELUSIVE NEUTRINOS. Dance, J. B. (Univ. of Aston, Birmingham, Eng.). Phys. Educ., 3: 298–306(Nov. 1968).

Neutrino physics is providing one of the most fascinating and challenging fields of natural philosophy. The existence of the neutrino was first postulated to account for certain radioactive

phenomena, but at that time it seemed unlikely that the particle would ever be detected. The field of experimental neutrino physics commenced about a decade ago with the detection of neutrinos emitted by a reactor. Since then experiments with neutrinos derived from the largest accelerators have shown that the muon neutrino is different from the electron neutrino. Both of these particles have corresponding antiparticles. High energy neutrino experiments are providing valuable information which is required for the checking of some of the theories of nuclear physics, especially those associated with the weak interactions. Experiments are being carried out to detect the neutrinos emitted by the sun, and also those formed by cosmic ray bombardment of the atmosphere. It remains to be seen whether the detection of neutrinos emitted by other astronomical objects, e.g., from a supernova, will be possible. It seems likely that ideas of cosmology will be profoundly affected by considerations of the part played by neutrinos in the evolution of the universe. (auth)

5523 EXPERIMENTAL DATA FOR $\mu \rightarrow e$ DECAY. Gurevich, I. I.; Nikolskii, B. A. (Inst. of Atomic Energy, Moscow). Usp. Fiz. Nauk, 95: 476-9(July 1968). (In Russian).

A summary of experimental data on the $\mu \rightarrow e + \nu + \bar{\nu}$ decay to check the form of the interaction is given and it is verified that experiment does not contradict a V−A interaction; however unequivocal determination of the type of interaction on the basis of existing experimental data is impossible. (tr-auth)

5524 SEARCH FOR A CP-NONCONSERVING ASYMMETRY IN THE DECAY $K_L^0 \rightarrow \pi^+\pi^-\pi^0$. Blanpied, W. A. (Case Western Reserve Univ., Cleveland); Levit, L. B.; Engels, E.; Goitein, M.; Kirk, T.; Ryan, D. G.; Stairs, D. G. Phys. Rev. Lett., 21: 1650-3(Dec. 9, 1968).

A possible CP-nonconserving asymmetry in the momentum spectra of the charged π mesons in the decay $K_L^0 \rightarrow \pi^+\pi^-\pi^0$ was searched for. No significant asymmetry was observed. Making the linear spectrum approximation, a value was obtained for the CP-nonconserving parameter, σ_+, $+0.001 \pm 0.004$. (auth)

5525 EXPERIMENTAL STUDY OF THE DECAY $K_L^0 \rightarrow \pi + e + \nu$. Aronson, S. H.; Chen, K. Wendell (Princeton Univ., N. J.). Contract AT(30-1)-2137. Phys. Rev., 175: 1708-24(Nov. 25, 1968).

A wide-gap magnetic-field spark chamber spectrometer was used to measure the pion-energy dependence of the form factor f_+ in $K_L^0 \rightarrow \pi^\pm + e^\mp + \nu_e$ decay (K_{e3}^0). Decays of neutral particles were detected in the 13° beam of the Princeton−Pennsylvania Accelerator, and K_{e3}^0 decays were identified by kinematical reconstruction, time-of-flight, and by electromagnetic showers in Čerenkov shower counters. The distribution of events according to their pion energy in the K_L^0 rest frame was used to determine the energy-dependence parameter λ in the form factor $f_+(q^2) = f_+(0)(1 + \lambda q^2/m_\pi^2)$, where $q^2 = M_K^2 + m_\pi^2 - 2E_\pi M_K$. Based on a comparison of the data with the distribution of a Monte Carlo sample of events generated with constant form factor, λ was determined to be $\lambda = +0.020 \pm 0.013$. The data are consistent with the single-particle-dominance model, where the intermediate state is the K*(890). The results, taken together with the value of λ in K_{e3}^+ decay are consistent with the predictions of the $|\Delta I| = \frac{1}{2}$ rule in semileptonic decays. (auth)

Strong (Baryon-Induced)

Refer also to abstract 5802.

5526 LIFETIME OF HEAVY HYPERFRAGMENTS. Bhalla, K. B. (Jodhpur Univ., India); Lokanathan, S.; Prakash, Y.; Singh, Triyug; Goel, S. P. Nuovo Cim., 58A: 249-58(Nov. 1, 1968).

The angular distribution of 173 recoils from the decays of heavy spallation hyperfragments, is measured. The forward to backward (F/B) ratio of these recoils with respect to the hyperfragment direction at the decay point is observed to be 2.0 ± 0.4. This asymmetry is related to the decays in flight of such hyperfragments and it is estimated that their mean life τ is likely to be in the range of $(0.8 \text{ to } 7.0) \cdot 10^{-12}$ s. (auth)

5527 EVIDENCE FOR STRONGLY INTERACTING HEAVY SHOWER PARTICLES AT 70 m w.e. UNDERGROUND. Dardo, M. (Univ., Turin); Penengo, P.; Sitte, K. Nuovo Cim., 58A: 59-86(Nov. 1, 1968).

An array consisting of a telescope of four scintillation counters separated by layers of 15 cm of lead, and six two-scintillator extension trays of a total area of 5.5 m^2 and with 5 cm lead absorbers, was operated at the Mt. Cappuccini station in Torino, 70 m w.e. underground. The pulse heights of the four telescope scintillators were displayed on an oscilloscope and photographed, so that the traversals of single particles could be distinguished from showers incident from the rock above or produced in the lead plates. The delays between the pulses in telescope and extension trays were also determined from the oscilloscope records. In the first part of the run events were recorded whenever a pulse in any detector of the array was followed, within 500 ns, by the passage of another particle through the telescope. In the second part all coincidences within ±250 ns were accepted. During the 1590 h of the first run, 34 particles with delays between about 40 and 120 ns were observed, of which 22 showed interactions in the lead plates of the telescope, indicating the presence of a strongly interacting component among the shower particles. In the following 1037 h of operation mostly short "negative" and "positive" delays were registered. At negative delays the nuclear-active component comprised some 55% of all shower particles. Its interaction mean free path was (165 ± 25) g/cm^2. A similar fraction of interacting particles was found for positive delays, but its interaction mean free path was substantially larger (≥375 g/cm^2), and its angular and lateral distributions significantly different. Measurement with increased lead absorbers confirmed that the nuclear-active component at negative delays was strongly attenuated, while that present at positive delays showed little attenuation losses. The interacting particles at negative delays can be identified as pions originating from nuclear interactions of single muons in the rock above the array. The most likely interpretation of the events observed at positive delays is that they are due to particles of a mass about 10 to 15 times larger than that of a nucleon, possibly heavy triplet particles of single charge. Their total flux is of the order 10^{-7}/cm^2 sr s. The apparent discrepancy between these results and those of earlier experimenters who gave upper flux limits of the order 10^{-10}/cm^2 sr s for the flux of massive particles can be explained by the assumption that these particles are created in catastrophic processes involving dissociation of the colliding primaries, with subsequent decay of the unstable triplet particles into muons. This would leave little or no energy for the production of an air shower. If that is so, the cross section for this process must be of the order of a few percent of the total inelastic cross section. (auth)

5528 EXPERIMENTAL COMPARISON BETWEEN ON- AND OFF-MASS-SHELL INELASTICITIES IN π^-p SCATTERING. Colton, Eugene (Univ. of California, Los Angeles); Schlein, Peter E.; Gellert, Eugene; Smith, Gerald A. Phys. Rev. Lett., 21: 1548-50(Nov. 25, 1968).

The mass spectra of the systems recoiling against peripherally produced Δ^{++} for the reactions $pp \rightarrow \Delta^{++}p\pi^-$, $pp \rightarrow \Delta^{++}p\pi^-\pi^0$, and $pp \rightarrow \Delta^{++}n\pi^+\pi^-$ at 6.6 GeV/c were investigated. The experimental cross-section ratios of these systems are found to be comparable with the known on-mass-shell cross section ratios $\sigma(\pi^-p \rightarrow \pi^-p)$: $\sigma(\pi^-p \rightarrow \pi^-p\pi^0)$: $\sigma(\pi^-p \rightarrow \pi^-n\pi^+)$ as a function of mass of the system m ≲ 1.8 GeV. This result is compatible with a one-pion-exchange interpretation for the production of the peripheral Δ^{++} component in these five-body states and furthermore suggests that $\pi\pi$ and $K\pi$ inelastic scattering may be realistically studied in the same way. (auth)

5529 CROSS SECTIONS FOR THE REACTIONS $\bar{p}p \rightarrow \pi^+\pi^-$ AND K^+K^- NEAR 2 GeV/c. Chapman, J. W.; Hess, F.; Lys, J.; Murphy, C. T.; Vander Velde, J. C. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett., 21: 1718-21(Dec. 16, 1968).

The differential and total cross sections for the reactions $\bar{p}p \rightarrow \pi^+\pi^-$ and $\bar{p}p \rightarrow K^+K^-$ have been measured at six laboratory momenta, ranging from 1.62 to 2.20 GeV/c. The $\pi^+\pi^-$ cross section falls from (137 ± 16) to (32 ± 8) μb over this interval while the K^+K^- cross section falls from (51 ± 10) to (21 ± 6) μb. The center-of-mass angular distributions for the two channels differ remarkably. (auth)

5530 HADRON PRODUCTION IN NUCLEON–NUCLEON COLLISIONS NEAR 800 GeV. Lamb, William Horton Jr. Auburn, Ala., Auburn Univ., 1968. 69p.

Five nuclear interactions of mean primary energy $E_p \approx 800$ GeV found in an Ilford G-5 emulsion stack flown for 17½ h at an altitude of 125,000 ft have been analyzed to identify the particles emitted in the backward c.m. cone. The interactions have been selected by a special method of scanning designed to eliminate bias toward high multiplicity events. Of the 13 charged secondaries, 8 were attributed to pions, 2 to kaons, 3 to protons, and 0 to hyperons. The average kinetic energy of the secondaries in the c.m. system is 3.0 GeV, the average inelasticity is 0.36, and the average transverse momentum is 0.048 GeV/c. The latter quantity is observed to decrease in the extreme emission angles. The results are compared to a field theoretic model proposed by Krisch. (Diss. Abstr.)

5531 SOME PROPERTIES OF INTERACTIONS BETWEEN ANTIPROTONS AT 3 GeV/c AND BOUND NUCLEONS. Tinland, Bernard. Cah. Phys., Nos. 207-208, 458-68(Nov.-Dec. 1967). (In French).

The experimental study of the interactions of antiprotons with

the nuclei of photographic emulsions led to conclusions with respect to reactions of the antiproton-bound nucleon type unaccompanied by significant excitation of the target nucleus. The antiproton-bound neutron type reactions are more numerous than those of the antiproton-bound proton type. The ratio of the two corresponding cross sections was found to equal $2.8^{+1}_{-0.5}$. This result is explained partially by the very large antiproton-neutron interaction cross section (112^{+40}_{-25} mb) announced by F. Bartholin and by the neutron excess in nuclei of the AgBr type. Among the interactions giving place to the re-emission of an antiproton with energy about equal to the incident energy, some of them can be considered as antiproton-nucleus elastic scatterings. There is a correlation between the emission angle of the fastest particle and its energy. The pion multiplicities do not seem to differ much for the $\bar{p}$-n and $\bar{p}$-p interactions. (tr-auth)

5532 LOW-ENERGY Λ-PROTON ELASTIC SCATTERING. Sechi-Zorn, B. (Univ. of Maryland, College Park); Kehoe, B.; Twitty, J.; Burnstein, R. A. Contract AT(40-1)-2504. Phys. Rev., 175: 1735-40(Nov. 25, 1968). (ORO-2504-123).

The cross sections for Λ-p elastic scattering with Λ momenta in the interval 110–330 MeV/c were measured. The results are based on 224 scattering events found in a sample of 95,600 Λ hyperons observed in an exposure of the 81-cm Saclay hydrogen bubble chamber to a stopping K^- beam. These cross sections are analyzed in terms of effective-range theory. A wide spectrum of solutions in this formalism gives acceptable agreement with the data. (auth)

5533 PROTON–NEUTRON TRIPLE SCATTERING AT 425 MeV. I. Wright, S. C. (Univ. of Chicago); Shawhan, D.; Pondrom, L.; Olsen, S.; Handler, R. Contract AT(11-1)-881. Phys. Rev., 175: 1704-7(Nov. 25, 1968). (COO-881-192).

The proton-neutron triple scattering parameters P, D, R, and A were measured at lab angles of 20, 30, and 42° at 425-MeV incident proton energy. Polarized protons were scattered from neutrons in deuterium, and the final proton polarization was measured with a carbon plate wire-spark-chamber system. The recoil neutrons were detected. p-p quasielastic scattering from deuterium was also studied at 30° and 42° as a check on the impulse approximation. (auth)

Strong (Meson-Induced)

Refer also to abstracts 5520, 5613, and 5621.

5534 (JINR-P1-4076) PRODUCTION OF TWO AND MORE π^0 MESONS IN π^+–Xe INTERACTIONS AT 2.34 GeV/c. Slovinskii, B.; Strugal'skii, Z. S. (Joint Inst. for Nuclear Research Dubna (USSR). Lab. of High Energy). 1968. 27p. (In Russian). Dep.

The results of the investigation of the π^0-meson characteristics, produced in π^+–Xe interactions at 2.34 GeV/c, are described. The average values of the longitudinal and transverse momentum components of π^0-mesons are given. The energy γ-quantum spectra and the $m_{2\gamma}$, $m_{3\gamma}$, $m_{4\gamma}$ effective mass distributions are presented. (auth)

5535 SPIN AND PARITY OF THE T = ½ Kππ SYSTEM NEAR 1.3 GeV. Chien, C. Y.; Dauber, P. M.; Malamud, E. I.; Mellema, D. J.; Schlein, P. E.; Schreiner, P. A.; Slater, W. E.; Stork, D. H.; Ticho, H. K.; Trippe, T. G. (Univ. of California, Los Angeles). Phys. Lett., 28B: 143-7(Nov. 11, 1968).

The Kππ Dalitz plots for the two reactions $K^+p \rightarrow K^0\pi^0\pi^+p$ at 7.38 GeV/c beam momentum in the effective mass interval $1.2 < M_{K\pi\pi} < 1.35$ GeV with N^{*++} ($1.13 < M_{\pi^+p} < 1.33$ GeV) excluded have been analyzed assuming coherent decay channels: $K\pi\pi \rightarrow K^*\pi$ and ρK. The results, favoring a spin and parity assignment $J^P = 1^+$ to the Kππ system, are supported by the observed correlations of the outgoing K and K* with the incident K^+. (auth)

5536 PRODUCTION OF THE g(1640) MESON IN πp INTERACTIONS AT 6 GeV/c. Crennell, D. J.; Karshon, U.; Lai, K. W.; Scarr, J. M.; Skillicorn, I. O. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett., 28B: 136-9(Nov. 11, 1968).

The results are presented of a spin determination of the $g_1^-(1640)$ meson from an analysis of its dipion decay mode ($\pi^-\pi^0$). It is found that spin three (or maybe greater) is favored. The observation of an isospin one $K\bar{K}$ enhancement at 1640 MeV is also reported which is consistent with a new decay mode of the g meson. A relative branching ratio of $(K\bar{K}/\pi\pi) \sim 8\%$ is obtained from our analysis. (auth)

5537 MULTIPLE MESON PRODUCTION IN PROTON–NUCLEON INTERACTIONS AT 22.6 AND 24 GeV/c. Hasegawa, Shunichi (Waseda Univ., Tokyo); Nanjo, Hirotada; Ogata, Takeshi; Sakata, Michinori; Tanaka, Kojiro. Progr. Theor. Phys. (Kyoto), 40: 673-7(Sept. 1968).

The inelastic interactions of 22.6- and 24-GeV/c protons with free or quasi-free nucleons in nuclear emulsions were studied. The data are analyzed in terms of multiplicity distribution and the differential angular distribution for each multiplicity. (L.B.S.)

5538 TRANSVERSE MOMENTUM DISTRIBUTION OF PIONS IN TWO AND SIX PRONG EVENTS FROM π^-p COLLISIONS AT 7.0 GeV/c. Ijaz, M. A.; Campbell, J. E.; Naeem, A. (Virginia Polytechnic Inst., Blacksburg). Can. J. Phys., 46: 2663-8(Dec. 1, 1968).

We have measured the transverse momentum distribution (p_t) of the pions produced in the BNL 80″ liquid hydrogen bubble chamber. The bubble chamber was exposed to a 7.0 GeV/c negative pion beam. We have measured 1000 two prong and 2000 six prong events. The p_t distribution for low multiplicity events represents production process via peripheral interactions whereas most of the high multiplicity events may correspond to collisions with large four momentum transfer to the nucleon. The p_t distribution of the pions has been fitted with an expression in the Hagedorn model for p_t. The effective temperature obtained from a least square fit of the pion p_t distribution for the two and six prong events is 132 ± 9 and 120 ± 3 MeV respectively. If we are justified in analyzing the p_t distribution of the low multiplicity events with the Hagedorn model, we find that there is no significant difference in the temperature of the peripheral and central region of the interaction volume. The temperature increases with an increase in the energy of the interaction. (auth)

5539 EVIDENCE FOR A NEW DECAY MODE OF THE X^0-MESON: $X^0 \rightarrow 2\gamma$. Bollini, D.; Buhler-Broglin, A.; Dalpiaz, P.; Massam, R.; Navach, R.; Navarria, R. L.; Schneegans, M. A.; Zichichi, A. (CERN, Geneva. Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna. Centre de Recherches Nucleaires, Strasbourg). Nuovo Cim., 58A: 289-96(Nov. 1, 1968).

The results are reported of a search for the 2γ decay of the X^0-meson from the reaction $\pi^- + p \rightarrow n + X^0$ at 1.93 GeV/c. Two shower detectors consisting of nine layers of lead, spark chamber, and scintillator sandwiched together were used to detect the gamma rays. Five indentified γ–γ events were observed in the mass region 962 ± 17 MeV. Evidence was found in support of the $J^{PC} = 0^+$ assignment to the X^0 quantum numbers. The cross section was found to be $\sim 8.8 \times 10^{-30}$ cm^2, and the branching ratio $\Gamma(X^0 \rightarrow 2\gamma)/\Gamma(X^0 \rightarrow \text{total})$ obtained was ~5.5%. (L.B.S.)

5540 COHERENT PRODUCTION OF $\pi^+\pi^+\pi^-$ IN DEUTERIUM BY 8-GeV/c π^+. Cnops, A. M. (Brookhaven National Lab., Upton, N. Y.); Hough, P. V. C.; Huson, F. R.; (and others). Phys. Rev. Lett., 21: 1609-12(Dec. 2, 1968).

A diffractively produced 3π enhancement is observed with mass ~1.1 GeV and width ~0.35 GeV. There is no structure observed in the peak in either the mass or angular distributions. The system is predominantly s-wave πp with a $3\pi\ 0^-$ admixture which is essentially constant in percentage and relative phase across the peak. (auth)

5541 π^-p BACKGROUND ELASTIC AND INELASTIC SCATTERING AT 2.15 GeV/c. Anthony, R.; Coffin, C. T.; Meanley, E.; Rice, J.; Stanton, N.; Terwilliger, K. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett., 21: 1605-8(Dec. 2, 1968).

Differential cross sections for the reactions $\pi^-p \rightarrow \pi^-p$ and $\pi^-p \rightarrow \pi^+N^{*+}(1236)$ at an incident pion momentum of 2.15 GeV/c and for center-of-mass scattering angles in the range $\cos\theta^* = -0.999$ to −0.950 were measured. The elastic differential cross section has a sharp dip in the backward direction, dropping from ~70 μb/sr at $\cos\theta^* = -0.95$ to ~4 μb/sr at $\cos\theta^* = -1$; the $N^{*-}(1236)$ differential cross section is, within our errors, consistent with the same size and shape as that for elastic scattering; the average differential cross section for $N^{*+}(1236)$ in our angular region is less than 18 μb/sr with 97% confidence. (auth)

5542 EVIDENCE FOR THE $K_1^0K_1^0$ ENHANCEMENT NEAR THRESHOLD PRODUCED BY K^-N INTERACTIONS. Alitti, Jean; Barnes, Virgil E.; Crennell, David J.; (and others) (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 21: 1705-8 (Dec. 16, 1968).

A $J^{PC} = 0^{++}$ $K_1^0K_1^0$ enhancement at a mass of 1030 ± 10 MeV with a width of 45^{+20}_{-15} MeV is observed in $\bar{K}N$ interactions. A s-wave resonance interpretation of this enhancement is favored over an s-wave scattering length effect. Within experimental uncertainties, we associate this enhancement with the S* observed in π^-p interactions. (auth)

5543 FOUR-PION DECAY OF THE f^0 MESON. Ascoli, G.; Crawley, H. B.; Mortara, D. W.; Shapiro, A. (Univ. of Illinois, Urbana). Phys. Rev. Lett., 21: 1712-15(Dec. 16, 1968).

The reaction $\pi^- p \rightarrow f^0 n \rightarrow 2\pi^+ 2\pi^- n$ has been observed at 5 GeV/c with $\sigma = 11.5 \pm 4$ μb ($1.20 < m_{4\pi} < 1.32$, $|t| < 0.2$ GeV^2). (auth)

5544 DIRECT EVIDENCE FOR THE MULTIPLET ASSIGNMENTS OF $\Lambda(1520)$ AND $\Lambda(1405)$. Tripp, Robert D.; Bangerter, Roger O.; Barbaro-Galtieri, Angela; Mast, Terry S. (Univ. of California, Berkeley). Phys. Rev. Lett., 21: 1721-4(Dec. 16, 1968).

A measurement has been made of the relative signs of the resonant $K^- p \rightarrow \Sigma\pi$ reaction amplitudes coming from partial waves corresponding to $\Sigma(1385)$, $\Lambda(1405)$, and $\Lambda(1520)$. From this it is shown that $\Lambda(1405)$ and $\Lambda(1520)$ are to be described as predominantly SU(3) singlets. (auth)

5545 MOMENTUM SPECTRA OF SECONDARY PARTICLES IN π-p INTERACTIONS AT 7.0 GeV/c. Campbell, James; Naeem, A.; Ijaz, M. A. (Virginia Polytechnic Inst., Blacksburg). J. Natur. Sci. Math., 8: 1-10(Apr. 1968).

Momentum spectra of the secondary particles produced by 7.0 GeV/c negative pions colliding with protons in a hydrogen bubble chamber are presented. The momentum spectra of events having six charged particles were measured. Also, transverse momentum distributions for the pions and protons are given. The mean transverse momentum for pions is approximately two times the rest mass of a pion and seems to be independent of the momentum of the incoming beam particle. Momentum distributions were calculated based on Lorentz invariant phase space and comparison is made with the experimental data. Deviations from the phase space momentum distributions were found. The deviations may be explained in terms of $\pi - N$ and multipion resonances found in the data. (auth)

5546 STRANGE PARTICLE PRODUCTION IN NEGATIVE PION–PROTON INTERACTIONS AT 7 GeV/c. Hsieh, Jen-shu. Columbus, Ohio, Ohio State Univ., 1968. 88p.

A number of experiments have been performed to study strange particle production in π^--p interactions at different energies. However, many more experiments, covering a much wider range of energies, must be performed to study the energy dependence of the branching ratios for the various final states and the formation of the various resonant states. The experiment was performed at the Brookhaven AGS, using the BNL 80'' bubble chamber. The film scanned for this investigation represented 0.43 μb. per event. Nearly 1700 events with two charged secondaries at the production vertex and having kinks (decays) and/or V-particles were measured. About 950 of these events could be fitted to the more than thirty different final states having associated strange particles. The data analysis was done by using the program TVGP for space reconstruction of each track and the program SQUAW for kinematic fitting of each event. Events were identified on the basis of both kinematic fitting and bubble density information. Nearly two-thirds of the fitted events were definitely assigned to a unique final state. The remainder of the events had more than one alternative fits which could not be ruled out on the basis of ionization estimates of χ^2 values. These events were classified as ambiguous events. The branching ratios for the fitted final states were calculated. The cross section for strange particle production at this energy was calculated to be 3.5 ± 1.2 mb. A study was made of the various resonances produced in the interactions studied. Only the definitely identified events were used for this part of the analysis. From the fitted momenta of the secondary particles, the invariant masses of two-body and three-body combinations such as $K\pi$, KN, $K\overline{K}$, $Y\pi$, YK, $K\pi\pi$, and $Y\pi\pi$ were calculated. It is found that $K^*(890)$ and $Y_1^*(1385)$ are most commonly produced. $\overline{K}^*(890)$ and $Y_1^*(1520)$ are also observed. There is evidence for the production of $\kappa(725)$, A1(1080) and $Y_1^*(1660)$. In addition, the results are consistent with the presence of $K_A(1250)$, A2(1300), $\pi(1640)$, and $N_{\frac{5}{2}}^*(1688)$. The $K^*(1440)$ and $Y_0^*(1405)$ observed at other energies are not seen in this experiment. However, some enhancements, such as the $K\pi$ combinations with $T = -\frac{3}{2}$ and $S = +1$ peaking around 950 MeV, and the $\overline{K}N + (\Sigma\pi)^+$ system with $T_3 = 0$ and $S = -1$ around 2600 MeV, are observed in this experiment. Neither of these bumps correspond to any known resonant states reported in the literature. The angular distributions of the $K^*(890)$ and $Y_1^*(1385)$ in the overall center-of-mass system are strongly peaked in the forward and the backward directions, respectively. Both of these angular distributions are consistent with the assumption that the interaction between the incoming pion and the target proton is peripheral in character, with a K or K^* being the exchange particle. (Diss. Abstr.)

5547 FINAL STATES WITH TWO OR MORE STRANGE PARTICLES FROM 4.25-BeV/c $K^- p$ INTERACTIONS. Abrams, G. S.; Glasser, R. G.; Kehoe, B.; Sechi-Zorn, B.; Wolsky, G. (Univ. of Maryland, College Park). Phys. Rev., 175: 1697-1704(Nov. 25, 1969). (ORO–2504–120).

Final states with two or more strange particles produced by 4.25-BeV/c $K^- p$ interactions were studied in a 5.3-event/μb exposure. A search for Ξ^* resonances found only the $\Xi^*(1530)$ produced in measurable amounts. The data suggest a $\Xi^*(2225)$ with isotopic spin $\frac{3}{2}$. The mass of the ϕ meson is measured to be 1021.5 ± 0.8 MeV from $\Lambda\phi$ events with $\phi \rightarrow K_1^0 K_2^0$. This result is 3 MeV higher than that found in other experiments using stopping K^+ and K^- mesons from $\phi \rightarrow K^+ K^-$. The results of a search for other meson and baryon resonances are presented. (auth)

5548 SEARCH FOR A STRANGE BOSON OF MASS LESS THAN 670 MeV. Kirsch, Lawrence (Brandeis Univ., Waltham, Mass.). Contract AT(30-1)-3178. Phys. Rev., 175: 1733-4(Nov. 25, 1968).

The cross section for the production of a strange boson in the mass region 565 to 670 MeV in the reaction $K^- p \rightarrow p\kappa^-$ is found to be less than 11 μb with 95% confidence. A crude theoretical estimate of the cross section based upon a simple pole model yields 11 μb. (auth)

5549 TWO-CHARGED-PARTICLE FINAL STATES OF $K^- p$ INTERACTIONS AT 2.63 AND 2.70 GeV/c. Ficenec, J. R.; Gordon, H. A.; Trower, W. P. (Univ. of Illinois, Urbana). Phys. Rev., 175: 1725-33(Nov. 25, 1968).

A study was made of 16,138 two-prong events at an averaged-incident kaon momentum of 2.66 GeV/c, using the 72-in. hydrogen bubble chamber and scanning and measuring projectors to determine the total and partial cross sections for the contributing reactions. For elastic scattering, the production distribution was measured and fitted with several models. The production and decay distributions for the $\overline{K}^*N$ final states were studied and the effective-mass distributions were obtained for the three-body final states. (auth)

Particle Interactions and Properties (Theoretical)

General

5550 (COO–1764-6) THEORETICAL AND HIGH ENERGY PHYSICS PROGRAMS. Progress Report, September 1, 1967–August 31, 1968. (Minnesota Univ., Minneapolis. School of Physics). Contract AT(11-1)-1764. 37p. Dep. CFSTI.

Research in theoretical nuclear physics and both theoretical and experimental high-energy physics at the University of Minnesota is reported. A list of publications is also presented. (W.H.K.)

5551 (NYO–3399-185) RESEARCH PROGRAM IN ELEMENTARY PARTICLE THEORY. Progress Report for the Period Ending November 30, 1968. Sudarshan, E. C. G. (Syracuse Univ., N. Y. Dept. of Physics). Contract AT(30-1)-3399. 57p. (SU–1206-185). Dep. CFSTI.

Research activities are briefly discussed including groups and infinite component wave equations, current algebras and chiral Lagrangians in strong, weak, and electromagnetic decays, dynamical models, theory of primary interactions, classical and quantum field theories, particles that move faster than light, and the kinematic structure of scattering amplitudes and decay widths. A list of recent publications is presented, and bibliographies and activities of the Syracuse University Theoretical Elementary Particle Physics Group are given. (W.H.K.)

5552 DYNAMICAL INTERRELATION OF WEAK, ELECTROMAGNETIC, AND STRONG INTERACTIONS AND THE VALUE OF θ. Cabibbo, N. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Maiani, L. Contract F 61 052 67 C 0084. Phys. Lett., 28B: 131-5(Nov. 11, 1968).

A new approach to hadron dynamics is described which includes the combined effects of weak and electromagnetic interactions. Symmetry breakings in the strong Hamiltonian are determined by weak and electromagnetic forces in a self consistent way. The effects of weak corrections, computed at second order with a cut-off Λ($G\Lambda^2 \approx 1$) coincide with those computed to all orders in a model with a neutral vector boson. A one parameter family of solutions is found, depending on θ, and comparison with the observed breaking parameters leads to $\sin\theta \approx 0.22$. (auth)

5553 CONDITION FOR THE CONVERGENCE FUNCTION IN A COMPOSITE MODEL OF ELEMENTARY PARTICLES. Bourrely, C.; Andriamboloiona, Raoelina (CNRS, Marseille). Nuovo Cim., 58A: 205-20(Nov. 1, 1968). (In French).

The convergence functions which may be introduced in the fermion-antifermion composite model are shown to be chosen among a class of entire functions; there is a minimum-decrease condition which is compatible with the theoretical bounds on the

cross section. Free-field commutation relations for the physical operators of elementary fermions, elementary antifermions and of composite bosons are also checked. (auth)

5554 INTRINSIC INVARIANCE GROUPS, MASS OPERATORS, AND LINEAR WAVE EQUATIONS. Rafanelli, Kenneth (City Univ. of New York, Flushing). Phys. Rev., 175: 1761-6(Nov. 25, 1968).

Relativity theory permits motions of a free-spinning particle in which the instantaneous velocity and linear momentum are not collinear. Therefore, it is necessary to specify two invariance groups in order to completely describe the space-time symmetry properties of a particle with intrinsic spin. If the quantal description of such a particle is given by a covariant linear field equation, then the external space-time symmetry is specified by the 10-element Poincaré group generated by the linear four-momentum and total angular momentum operators. However, invariance of the field equation under external inhomogeneous Lorentz transformations does not complete the algebra of the 10-element group generated by the instantaneous four-velocity and spin angular-momentum operators. Several formulations of linear field equations admitting a mass-spin spectrum are based on different choices for this latter, intrinsic, space-time symmetry group. The simplest choice, namely, intrinsic Poincaré invariance is considered and the formal connection between these several formulations is established by constructing a unitary transformation which generates an infinite sequence of linear wave equations describing ascendingly more complex intrinsic space-time symmetry, but linked by a common mass operator. Of special interest is the infinitesimal transformation which generates the familiar intrinsic DeSitter group. Finally, some kinematical properties of this transformation are discussed for various proposed mass operators. (auth)

5555 SPHERICAL KEMMER TOP. Rafanelli, Kenneth (TRW Systems, Redondo Beach, Calif.). Phys. Rev., 175: 1947-8(Nov. 25, 1968).

Kemmer's equation is modified to include the rotational contribution to the rest energy characteristic of a spherical top. The resulting representation-invariant eigenvalue equation is solved, giving the rest energy as a function of the spin. An order-of-magnitude calculation yields a mass difference for the two superposed spin states characteristic of the elementary particles. (auth)

Electromagnetic

Refer also to abstracts 4836, 5512, 5515, 5615, 5639, and 5949.

5556 (JPRS-45594) RADIATION EFFECTS IN EXPERIMENTS WITH OPPOSED ELECTRON-POSITRON BEAMS. Sukhanov, S. M. Translated from Dokl. Akad. Nauk SSSR, 178: 822-4(1968). 4p. CFSTI.

This paper was previously abstracted from the original language and appears in NSA as 22: 29659. (W.H.K.)

5557 (SC-RR-68-619) ANALYTICAL APPROXIMATIONS FOR TOTAL PAIR-PRODUCTION CROSS SECTIONS. Biggs, Frank; Lighthill, Ruth (Sandia Corp., Albuquerque, N. Mex.). Sept. 1968. Contract AT(29-1)-789. 22p. Dep. CFSTI.

Analytical approximations which are efficient for use in computer programs are given for total pair-production cross sections for atomic numbers $1 \leq Z \leq 100$ in the photon energy interval $1022.012 \leq E \leq 10^5$ keV. Graphs of cross sections and approximation parameters in tabular form are included. (auth)

5558 VECTOR MESON DOMINANCE MODEL AND π^2 PRODUCTION BY UNPOLARIZED AND LINEARLY POLARIZED PHOTONS. Krammer, M.; Schildknecht, D. (Deutsches Elektronen-Synchrotron, Hamburg). Nucl. Phys., B7: 583-600 (1968).

Using the vector meson dominance model, it is shown that the polarization of vector mesons produced in meson nucleon collisions yields information on pion production by linearly polarized photons. Combining vector dominance and a quark-model relation the cross section for charged pion production by linearly polarized photons is predicted. Moreover, the unpolarized π^2 cross sections calculated from the vector dominance and quark-models are compared with recent experiments. (auth)

5559 ANALYSIS OF SINGLE π^- AND π^+ PHOTOPRODUCTION OF DEUTERIUM AT HIGH ENERGIES AND LOW MOMENTUM TRANSFERS. Schilling, K. (Univ., Hamburg). Nucl. Phys., B7: 498-506(1968).

Using impulse approximation and accounting for the complete spin-isospin structure of the deuteron, it is shown that the photoproduction of single charged pions on the deuteron is suppressed by a factor of about $1-\frac{1}{3}S(q)$ (S, q denote the deuteron form factor and the momentum transfer to the pion) with respect to the photoproduction on the free nucleon. For π^+ photoproduction the Glauber correction is estimated to be less than 12%. (auth)

5560 ANALYSIS OF THE PHOTOPRODUCTION OF ω MESONS. Schilling, K.; Storim, F. (Univ., Hamburg). Nucl. Phys., B7: 559-73(1968).

Recent bubble-chamber data from the Aachen-Berlin-Bonn-Hamburg-Heidelberg-München Collaboration on the process $\gamma p \rightarrow p\omega$ are analyzed assuming that ω photoproduction goes both via diffraction and via elementary pion exchange, where the latter is modified by final state absorption and by the intermediate $\rho^0 p$ state. Bearing in mind the simple assumptions made on the spin structure of the diffraction amplitudes, reasonable agreement of this model with the data is found. (auth)

5561 $\eta \rightarrow 3\pi$ AND POSSIBLE LARGE VIOLATION OF PARTIAL CONSERVATION OF AXIALVECTOR CURRENT FOR η. Fujii, Yasunori (College of General Education, Tokyo). Nucl. Phys., B7: 601-14(1968).

The decay $\eta \rightarrow 3\pi$ is examined from the point of view of chiral dynamics. In order to obtain a result which agrees with experiment we suggest that PCAC might be largely violated for the η. The decay $K \rightarrow 3\pi$ is also re-examined along the same line of argument. (auth)

5562 REGGE-POLE DESCRIPTION OF THE PHOTOPRODUCTION OF VECTOR MESON. Daboul, Jamil (Univ. of California, San Diego, La Jolla). Nucl. Phys., B7: 651-83(1968).

A Regge-pole model is used to describe the spin density matrices of the vector mesons as well as the differential and total cross sections in the photoproduction processes: $\gamma + p \rightarrow V + p$($V = \rho^0$, ω and φ). (auth)

5563 COMPTON EFFECT ON RELATIVISTIC ELECTRONS. Haug, Eberhard (Univ., Tuebingen, Ger.). Z. Naturforsch., 23a: 1295-1301(Sept. 1968). (In German).

The differential cross section $d\sigma/dk_2$ (k_2 = energy of the scattered photons) was calculated as a function of the angle θ_1 between the incident photon and electron for the Compton effect on moving electrons. With the help of an approximation formula derived from this for high electron initial energy ϵ_1 and photon energies $k_1 \ll \epsilon_1$, the mean effective cross section $\Phi(\epsilon_1, k_1, k_2)$ at isotropic photon distribution was derived. A generalization of the Ginzburg and Sirovatskii formula was obtained. The effective cross section is graphically represented for various electron energies, which are of significance also in astrophysics. (tr-auth)

5564 QUASICLASSICAL THEORY OF BREMSSTRAHLUNG OF RELATIVISTIC PARTICLES. Baier, V. N.; Katkov, V. M. (Novosibirsk State Univ., USSR). Zh. Eksp. Teor. Fiz., 55: 1542-54(1968). (In Russian).

Photon emission by a relativistic particle in an external field is considered. The analysis is performed for fields in which the contribution to the radiation in a given direction is made by the whole particle trajectory. A generalization of the operator quasiclassical method previously proposed by the authors is employed. Emission by particles with spin 0 or $\frac{1}{2}$ in a Coulomb field is investigated in detail. Closed expressions are obtained which are valid for arbitrary values of $Z\alpha$. General formulas are also derived for the photon emission cross sections in the cases when (a) the fields decrease more rapidly than a Coulomb field and (b) only a small part of the trajectory contributes to the emission in a given direction. (auth)

5565 FURTHER SEARCH FOR S = +1 BARYON STATES IN PHOTOPRODUCTION. Mori, S.; Greenberg, J. S.; Hughes, V. W.; Lu, D. C.; Rothberg, J. E.; Thompson, P. A. (Yale Univ., New Haven). Contract AT(30-1)2726. Phys. Lett., 28B: 152-4 (Nov. 11, 1968).

The photoproduced K^- yield from hydrogen has been studied at a laboratory angle of 15° in a further search for strangeness S = +1 baryon states. The upper limit for differential cross sections for resonant states is about 4 nb/sr. (auth)

5566 ON THE ELECTROMAGNETIC AND GRAVITATIONAL INTERACTIONS AND SCHWINGER TERMS. Ezawa, Yasuo; Kimura, Toshiei (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 40: 640-56(Sept. 1968).

It is shown that a massless particle with spin $s \geq 2$ cannot have the usual gravitational interaction, following the procedure of Case and Gasiorowicz who showed that a massless vector particle has not the minimal electromagnetic interaction. The Schwinger terms are investigated for these cases, especially for a massless vector particle in an electromagnetic field. The results suggest that the vanishing of the equal-time commutator among sources leads to a vanishing of the sources themselves

as operators, i.e., the absence of interactions. The properties of the commutator among the non-conserved gravitational sources are investigated in the case where the minimal gravitational interactions are assumed to exist. In order that the energy-momentum tensor operator does not vanish, it is redefined as the limit of a non-local two point operator. In connection with gauge invariance, a reasonable energy-momentum tensor is proposed for a scalar particle in general relativity. (auth)

5567 ON THE THEORY OF DOUBLE-PION PHOTOPRODUCTION AT LOW ENERGIES. Lueke, D. (Univ., Hamburg); Scheunert, M.; Stichel, P. Nuovo Cim., 58A: 234-48(Nov. 1, 1968).

The process $\gamma + p \rightarrow \Delta^{++}(1236) + \pi^-$ at low energies is discussed by taking into account the gauge-invariant extended OPE contribution and a small admixture of isobaric contributions. Reasonable agreement with recent experimental data from the Aachen-Berlin-Bonn-Hamburg-Heidelberg-München collaboration was obtained. (auth)

5568 FIXED POLES IN FIRST-ORDER WEAK OR ELECTROMAGNETIC AMPLITUDES. Lu, E. Y. C. (Ohio State Univ., Columbus). Nuovo Cim., 58A: 34-42(Nov. 1, 1968).

A recently proposed sum rule for the photoproduction amplitude of on-shell pion is examined. The sum rule was derived on the basis of a postulated equal-time commutator between the electromagnetic current and the source current of the pion. The sum rule, if true, requires the existence of fixed poles in the on-shell-photoproduction amplitude. It is shown that the commutator in question in fact vanishes when the pion is on the mass shell and further that the t-channel singularities on both sides of the sum rule fail to match. It is concluded, therefore, that the sum rule does not hold and that first-order weak or electromagnetic amplitudes could be Reggeized. These considerations are then verified in simple field-theory models. The implications of superconvergent relations for first-order amplitudes are discussed. (auth)

5569 TEST OF THE VECTOR-DOMINANCE MODEL BY FORWARD AND BACKWARD ρ^0 PION PRODUCTION. Derado, Ivan; Guiragossian, Zaven G. T. (Stanford Linear Accelerator, Calif.). Phys. Rev. Lett., 21: 1556-8(Nov. 25, 1968).

The validity of the vector-dominance model has been tested by ρ^0 pion production at 4 GeV and π^+ photoproduction data. In the forward direction, a remarkable agreement has been observed with the photoproduction data, down to t_{min}. ρ^0 pion production in the backward direction shows good agreement through this model with available photoproduction data in the u channel. A comparison is made with theoretical work on Δ-Regge trajectory exchange. (auth)

5570 DETERMINATION OF THE ISOTENSOR ELECTROMAGNETIC CURRENT FROM PION PHOTOPRODUCTION. Gittelman, B.; Schmidt, W. (Stanford Univ., Calif.). Phys. Rev., 175: 1998-2002(Nov. 25, 1968).

Some consequences of an isotensor component of the electromagnetic current are examined in simple pion photoproduction. An experiment to detect the isotensor contribution in pion photoproduction from deuterium (already suggested by several authors) is reformulated to improve the sensitivity of the test. To estimate how accurately the experiment should be performed, upper bounds on the strength of the isotensor contribution are obtained from our experimental and theoretical knowledge of pion photoproduction from the nucleon. This limit turns out to be much smaller than previously stated in the literature. (auth)

5571 EXACT CALCULATION OF PAIR PRODUCTION. Oeverboe, Ingjald; Mork, Kjell J.; Olsen, Haakon A. (Univ. of Trondheim, Norway). Phys. Rev., 175: 1978-81(Nov. 25, 1968).

Positron spectra and total cross sections for pair production in the field of an atom are calculated for a range of values of the atomic number and for photon energies below about 2.5 MeV. Screening effects by the atomic electrons are neglected. Good agreement with earlier theoretical calculations and with available experimental results is obtained. (auth)

5572 DETERMINATION OF THE PION FORM FACTOR BY ELECTROPRODUCTION OF PIONS. Lambrakos, K. F.; Griffy, T. A. (Univ. of Texas, Austin). Phys. Rev., 175: 1848-50 (Nov. 25, 1968).

The isospin symmetry of the strong interactions is used to reduce some of the theoretical uncertainties involved in the extraction of the pion electromagnetic form factor from data on the electroproduction of pions. It is found that a comparison of the cross sections for production of charged (σ^+) and neutral (σ^0) pions permits some reduction in the theoretical uncertainties involved in obtaining the pion form factor. (auth)

5573 PION PHOTOPRODUCTION AND FIXED-t DISPERSION RELATIONS. Engels, J. (Univ., Karlsruhe, Ger.); Muellensiefen, A.; Schmidt, W. Phys. Rev., 175: 1951-64(Nov. 25, 1968).

The dispersion-theoretic models of the isobar approximation which predict single-pion photoproduction in the region of the $\Delta(1236)$ resonance are reviewed. The differences between the various models are explained and their consequences discussed. Considerable efforts are made to look for further improvements of the theory from the confrontation of theory and experiment. Anticipating the development of experimental techniques, an example for a more complete photoproduction experiment is discussed. Specifically, the usefulness of a π^0-photoproduction experiment with polarized γ's and/or polarized target for the region of the $\Delta(1236)$ resonance is studied. (auth)

5574 SPECTRUM CORRECTION FACTORS IN η, $K \rightarrow 3\pi$ DECAY. Kenny, Brian G. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev., 175: 2054-7(Nov. 25, 1968).

It is pointed out that, if one takes account of the structure in η, $K \rightarrow 3\pi$ decay, then the spectrum correction factors are altered substantially from the phase-space factors quoted under the assumption of a constant matrix element. Furthermore, it is noted that the calculation of the spectrum correction factors is not unique without making some theoretical assumptions about the details of the structure of the decays. In particular, the ambiguity of the spectrum correction factors is considered for two models which are consistent with the present data. (auth)

5575 $SU(6)_W$ AND HIGH-ENERGY PHOTOPRODUCTION. Meshkov, S.; Ponzini, R. (National Bureau of Standards, Washington, D. C.). Phys. Rev., 175: 2030-4(Nov. 25, 1968).

$SU(6)_W$ is used to make quantitative predictions for forward photoproduction cross sections at high energies. The predicted ratios for $\sigma(\gamma p|K^+\Sigma^0)/\sigma(\gamma p|K^+\Lambda)$, which vary from 0.5 to 1.0 for incident photons of energy 5 to 16 GeV, are in good agreement with the SLAC experiments. This is in contrast to the quark-model prediction of 1/27. The forward $\rho^0 p$ and ωp photoproduction cross sections also agree very well with experiment, but the φp cross section is too large by a factor of 2. (auth)

5576 HIGH-ENERGY POLARIZED-PHOTON REACTIONS. Thews, Robert L. (Univ. of California, Berkeley). Phys. Rev., 175: 1749-56(Nov. 25, 1968).

A general formalism is presented for the analysis of production and decay distributions of meson-baryon final states resulting from interactions of polarized photons and nucleons. Particular emphasis is given to high-energy reactions and Regge-pole exchange models. Circular polarization is shown to provide a test for the presence of two or more exchanges. Linear polarization parallel or perpendicular to the production plane allows the contributions of opposite J-parity exchanges to be separated. This formalism enables one to make use of data at all angles, rather than limit consideration to discrete points. Applications include the separation of diffractive and pion-exchange contributions to vector-meson production, and tests for non-pole-type exchanges in baryon-resonance production. Examination of pion photoproduction reveals that no simple test exists for the discrimination between pion conspiracy and evasion models. (auth)

5577 VERTEX-STRENGTH-ALGEBRA TREATMENT OF VECTOR-MESON PHOTOPRODUCTION. Hirshfeld, A. C.; Horwitz, L. P. (Tel-Aviv Univ., Israel). Phys. Rev., 175: 1865-8(Nov. 25, 1968).

An extension of the Regge model, using vector dominance and the scheme of Cabibbo, Horwitz, and Ne'eman for the calculation of factorized Regge residues, is applied to the photoproduction of vector mesons. Using parameters obtained from elastic meson-nucleon and nucleon-nucleon scattering, the photoproduction cross section is found to be consistent with the data, and the well-known problem with respect to the suppression of ϕ production is resolved. Total vector-meson-nucleon and γ-nucleon high-energy cross sections are also calculated, using the same parameters, and are found to be in agreement with the data. (auth)

5578 EQUAL-TIME COMMUTATORS AND ELECTROMAGNETIC MASS SPLITTINGS. Boulware, David G. (International Centre for Theoretical Physics, Trieste, Italy); Deser, S. Phys. Rev., 175: 1912-33(Nov. 25, 1968).

The relation between electromagnetic mass shifts (or splittings) to order α and equal-time commutators is analyzed. If the invariants in the forward spin-averaged Compton amplitude go as k^{-2} for $k^2 \rightarrow \infty$, it is possible to relate the quadratic and logarithmic divergences in δm^2 to certain Lorentz scalars formed from the commutators. These results are illustrated by models with currents bilinear or linear in canonical fields. The Jost–Lehmann representation is then used to analyze more general behavior. It is shown that the spectral function may generate a higher-rank tensor character of the amplitude than that expected from its kinematic factors. The relation is then more complicated even if the commutators still exist. Finally, detailed criteria for the existence of equal-time commutators are developed. (auth)

5579 CORRECTIONS TO THE COLEMAN–GLASHOW SUM RULE. Fels, Stephen Brook (Univ. of California, Los Angeles). Phys. Rev., 175: 1895-1904(Nov. 25, 1968).

The Fubini–Furlan–Rossetti formalism was used to calculate the lowest-order correction to the Coleman–Glashow (CG) electromagnetic mass sum rule. The e^2g corrections to each of two Gell–Mann–Okubo-like sum rules were computed approximately; the difference of these two sum rules is the CG expression, and of course the difference of the two corrections is the correction to the CG rule. Only those intermediate states containing one octet baryon and one photon were included in the calculation of the spectral density function. The vertex renormalization constants at zero momentum transfer may not be neglected in order e^2g, and were computed by techniques suggested by the above authors. Again, the relevant sum over states included (octet + 1 photon) states. The neutron and proton form factors used are those found in experiments at the Cambridge Electron Accelerator, and were related to the unknown strange-particle form factors via unbroken SU(3). The correction found in this manner is surprisingly small, being only 0.019 MeV. The difference between this value and experiment is within the probable error of the latter. (auth)

Weak

Refer also to abstracts 5515, 5522, 5561, 5574, 5640, and 5668.

5580 WEAK SELF-MASSES, CABIBBO ANGLE, AND BROKEN $SU_2 \times SU_2$. Gatto, R. (CERN, Geneva); Sartori, G.; Tonin, M. Phys. Lett., 28B: 128-30(Nov. 11, 1968).

An excellent determination of the Cabibbo angle is obtained by relating it to strong interaction parameters through the requirement that weak self-masses be free of quadratic divergences. Speculations are presented as to a relation of both the angle and $SU_2 \times SU_2$-breaking to electromagnetism. (auth)

5581 HIGH ENERGY NEUTRINO REACTIONS AND PHYSICAL INTERPRETATION OF THE WEAK ANGLE BY THE THEORY OF WEAK BOSONS. Igarashi, Masataka; Nakamura, Seitaro (Tokyo Univ. Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 40: 576-93(Sept. 1968).

Of the neutrino reactions, the quasi-elastic reactions (I) $\nu_l + n \rightarrow p + l^-$, $\bar{\nu}_l + p \rightarrow n + l^+$ and (II) $\bar{\nu}_l + N \rightarrow Y + l^+$ are studied in the theory of weak bosons. It is assumed that all form factors have the same analytic form and the same effective mass as that of the isovector part of the nucleon electromagnetic form factor. In comparison with the results of the local (Fermi) interaction theory, the results of the present work on the weak boson theory are in better agreement with recent observations in the following points: (A) The total cross sections for the neutrino reactions (I) and (II) become smaller than those of the local interaction theory. (B) The ratios of the two reactions (I) and (II), with regard to the total cross sections also become smaller. (C) As for the differential cross sections, the weak boson theory leads to a larger ratio of the forward to the backward than that predicted by the local interaction theory. The existence of one or two kinds of weak bosons, W_0 (which couples with the $\Delta S = 0$ baryon currents) and W_1 (which couples with the $\Delta S = 1$ baryon currents) is also assumed, and an explanation of the physical meaning of the weak angle θ in terms of these bosons is suggested. The experiments on the total cross section and the differential cross section for quasi-elastic neutrino reactions are in favor of our prediction, which may be considered as strong, although indirect, support for our assumption that weak bosons should exist. (auth)

5582 S AND P "CURRENTS" AND THE NONLEPTONIC HYPERON DECAYS. Bailin, David (Univ. of Sussex, Brighton, Eng.). Progr. Theor. Phys. (Kyoto), 40: 557-70(Sept. 1968).

A variety of current × current nonleptonic Hamiltonians constructed from a scalar (S)-pseudoscalar(P) "current" interacting with itself is considered. While some of these Hamiltonians are more fruitful than others, it is found that most of them are consistent with the present data on the s-wave nonleptonic hyperon decays, although some of them must be considered as rather pathological objects. (auth)

5583 COMMENT ON INTERRELATION BETWEEN WEAK FOUR-FERMION INTERACTION AND WEAK BILINEAR INTERACTION. Fujii, Kanji; Furui, Shin-ya (Hokkaido Univ., Sapporo. Australian National Univ., Canberra). Progr. Theor. Phys. (Kyoto), 40: 571-5(Sept. 1968).

It is shown that the theory on a possible interrelation between the weak four-fermion interaction and the weak bilinear interaction developed by the present authors and others, and the one developed by Nakagawa, have equivalent contents in the fundamental triplet model. (auth)

5584 RENORMALIZATION OF THE $K_{\ell 3}$ FORM FACTOR. Jones, P. B. (Oxford Univ.). Phys. Rev. Lett., 21: 1553-5 (Nov. 25, 1968).

The renormalization of the $K_{\ell 3}$ form factor by the strong SU(3)-nonconserving interaction is calculated from the Fubini-Furlan sum rule and an experimental determination of the derivative of the matrix element of the divergence of the strangeness-changing current. The calculated renormalization is in agreement with that determined from measurements of ft values in Fermi nuclear β transitions and of the absolute rate for $K^+ \rightarrow e^+\pi^0\nu$. (auth)

5585 IS INVARIANCE VIOLATED? Lalovic, D. I. (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). Phys. Rev. Lett., 21: 1662-5(Dec. 9, 1968).

The well-known fact that the existing quantum mechanical formalism is inconsistent with the energy-time uncertainty-relation postulate is shown to play a crucial role in the logical deduction leading to the conclusion that CP invariance is violated in some neutral kaon decays. It is therefore argued that if one believes in the existence of the energy-time uncertainty relation, then one has to accept that none of the existing experimantal facts can unambiguously be interpreted as evidence against the universal validity of CP invariance. (auth)

5586 NUCLEAR PARITY VIOLATION TESTS OF NON-LEPTONIC WEAK CURRENTS. Henley, E. M. (CERN, Geneva). Phys. Lett., 28B: 1-3(Oct. 28, 1968).

Nuclear gamma-ray transitions are proposed to detect a $\Delta I = 1$, $\Delta Y = 0$ weak interaction. The circular polarizations in ^{18}F and ^{10}B transitions may be particularly suitable. (auth)

5587 ELECTROMAGNETIC CORRECTIONS FOR NEUTRINO (ANTINEUTRINO)–NUCLEON INTERACTION WITH LEPTON FORMATION. Kasumov, Y. M.; Kerimov, B. K.; Tsvetkov, V. P. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 5, 99-102(Sept.–Oct. 1968). (In Russian).

Continuation of the work previously carried out by the authors on neutrino (antineutrino)–nucleon interactions forming leptons is described. The studies are confined to the two-component and four-component theories for two neutrino and calculations are made of electromagnetic corrections of α order for the processes of elastic production of leptons of high energy neutrino: $\bar{\nu}_l + p \rightarrow n + \bar{l}$ (1) and $\nu' + p \rightarrow n + \mu^+$ (2) where $\bar{l} = e^+$ or μ^+, $\nu_l = \bar{\nu}_e$ or ν_μ. The reaction (1) $\bar{\nu}_\mu p \rightarrow n\mu^+$ is permissible for the two-component ($\bar{\nu}_\mu = \bar{\nu}_R$) and the reaction (2) for four-component ($\nu' = \nu_R$) neutrino theory. (R.V.J.)

5588 ULTRAVIOLET DIVERGENCES IN RADIATIVE CORRECTIONS TO WEAK DECAYS. Preparata, Giuliano; Weisberger, William I. (Princeton Univ., N. J.). Phys. Rev., 175: 1965-74 (Nov. 25, 1968).

The problem of second-order radiative corrections to general semileptonic weak decays is considered. Previous results on ultraviolet divergences in the calculations for zero-momentum-transfer β decays can be proven for the general process, provided that the models of the strong interactions are restricted to renormalizable theories of elementary fermion fields coupled to neutral massive vector bosons through a conserved vector current. A possible method for calculating finite radiative corrections to actual processes is also discussed. (auth)

5589 MOMENTUM-DEPENDENT $K_{\ell 4}$-DECAY FORM FACTORS. Dutt, Ranabir; Gupta, K. C.; Vaishya, J. S. (Univ. of Delhi). Phys. Rev., 175: 1884-91(Nov. 25, 1968).

$K_{\ell 4}$ decays are considered within the framework of SU(3) × SU(3) algebra. An effort was made to obtain the momentum dependence of the axial-vector form factors involved in these decays. To achieve this, zero-mass external pions ($p^2, q^2 \rightarrow 0$ are studied, where p and q are the four-momenta of the two pions), unlike the soft pions ($p, q \rightarrow 0$) incorporated in earlier current-algebra calculations of $K_{\ell 4}$ decays. Further, the recently developed on-mass-shell three-point functions are used throughout the analysis. An estimate is also made of the weak-amplitude term involving K- and Q-meson poles and the scalar term involving the σ meson. In this way, momentum-dependent $K_{\ell 4}$-decay form factors are obtained. These are used to calculate the dipion energy spectrum, decay rates, and the vector form factor. The fair agreement obtained with the experimental data is indirect evidence of small s-wave final-state interactions. The calculation neatly brings out the fact that the $K_{\ell 4}$-decay form factors have significant momentum dependence. (auth)

5590 CHIRAL SU(3) × SU(3) THREE-POINT FUNCTIONS: SINGLE-PARTICLE APPROXIMATION. Gerstein, Ira S. (Massachusetts Inst. of Tech., Cambridge); Schnitzer, Howard J.; Contract AT(30-1)-2098. Phys. Rev., 175: 1876-83(Nov. 25, 1968).

The three-point functions constructed previously are approxi-

mated by using a single-particle approximation to all propagators and assuming that the primitive three-point functions are slowly varying functions of the momenta. The available data on strong and weak decays of spin-one and spin-zero mesons are used to compute the values of the parameters introduced in our model, with special reference to K_{l3} decay. (auth)

Strong (General)

Refer also to abstract 5606.

5591 QUARK MODEL WITH FACTORIZABILITY ASSUMPTION: APPLICATION TO INELASTIC PROCESSES. Ikeda, Miyo; Kawaguchi, Masaaki; Yokomi, Hiroyuki (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 40: 594-604(Sept. 1968).

The quark model with factorizability assumption, which has been introduced in previous papers, is applied to two-body inelastic processes. Various relations for the differential cross section are obtained, some of which are compared with experimental data. (auth)

5592 A NEW TYPE OF NON-DYNAMICAL PARITY TEST FOR UNSTABLE PARTICLES. Kielanowski, Piotr (Univ. of Warsaw). Nucl. Phys., B7: 674-80(1968).

The reaction $\frac{1}{2} + 0 \rightarrow s_3 + s_4$ is considered, in which the particles s_3 and s_4 are assumed to be unstable. A nondynamical test for parity (with polarized target) is proposed, in which only the knowledge of the angular distribution of momenta or the normal to the decay plane (in the case of three-particle decays) of the decay products is needed. Some more important cases are considered in detail. (auth)

5593 RESONANCE-GENERATING MECHANISMS. Nagy, Elemer (Central Research Inst. for Physics, Budapest). Magy. Fiz. Foly., 16: 401-20(1968). (In Hungarian).

In the strong interaction of elementary particles, at a certain energy of the newly-created particles the cross section may be increased abruptly; at the same time the system acquires specific quantum numbers, such as a given impulse momentum, parity, isospin, strangeness, etc. This sudden increase recalls common resonance phenomena, and therefore the resulting particles were designated as "resonances". The mechanisms which generate resonances may be classified depending whether all or only a portion of the final state particles form resonances. The multichannel modification of partial waves, the peripheral interaction, quasielastic collisions, Fermi's independent particle model, and the one-pion-exchange model are reviewed. The importance of false resonances for high-energy physics is examined, pointing out that these mechanisms are mostly limited to the vicinity of the generating threshold; they may be eliminated by increasing the energy. If this is not possible, the observed mass peak must be double-checked by other methods (Review article, 22 references). (TTT)

5594 QUASI-INDEPENDENT QUARK MODEL. Bogolyubov, P. N. Ann. Inst. Henri Poincare, Sect. A, 8: 163-89(1968). (In French).

One of the simplest baryon models, which is comparable up to a certain point to a model of the atomic nucleus, is examined. In order to study the problem of bound states in a system of three quarks in strong interaction with each other, it is assumed that at the interior of the baryons the quarks are independent particles in a mean self-consistent field. The wave functions of the quark system and the individual quarks are described by the usual Dirac equations for particles in a given field. As in the shell model of the nucleus, the binding energy of the nucleons is weak in comparison with their eigenenergy and the mass defect creating the binding energy of the nucleons is weak with respect to the mass of the nucleus. In the case considered of the quark baryon model the quark mass is assumed much larger than the baryon mass and the mass defect is almost equal to the sum of the masses of the three quarks (in the free state). The number of quarks is probably insufficient for the mean field concept to have its complete meaning. Also in order to obtain correct results the Pauli principle must be suppressed for the quarks. It is necessary that the wave function of the three-quark system not be an antisymmetric function but a symmetric function of the quark variable. Two possibilities are given for overcoming this fundamental difficulty. (J.S.R.)

5595 MESON AND BARYON RESONANCES, SCATTERING AMPLITUDES. Galfi, Laszlo; Kunszt, Zoltan (Lorant Eoetvoes Univ., Budapest). Magy. Fiz. Foly., 16: 313-45(1968). (In Hungarian).

Recent studies revealed that the meson and baryon states of atoms, molecules and nuclei possess a fundamental structure: the hadron states may be viewed as triplet objects, corresponding to the SU(3) representation, as indicated by Gell-Mann. The SU(6) symmetry, based on the spin and isospin fields, discovered in 1964, supports this assumption. This model was used for the phenomenological description of resonances; they represent the 3 and 6-dimensional basis of the SU(3) and SU(6) systems, respectively. It was attempted to identify quarks by means of accelerator experiments, cosmic ray studies and spectroscopic examinations; it was concluded that additional theoretical studies are greatly needed. Recent studies carried out at Berkeley and at CERN are critically reviewed. The nucleon resonances, the πN scattering and the application of the SU(3) symmetry in strong interactions are studied in greater detail within the framework of baryon resonances. (TTT)

5596 SOME NEW RESULTS OF THE HIGH-ENERGY REGGE POLE THEORY. Sebestyen, Akos; Suranyi, Peter (Central Research Inst. for Physics, Budapest). Magy. Fiz. Foly., 16: 347-70(1968). (In Hungarian).

Many experiments have been carried out recently on the clarification of high-energy interaction phenomena; the results made it possible to compare the Regge-pole theory with experimental data. It was found that the theory is able to explain all fundamental questions and to clarify some of the apparent contradictions, such as the energy dependence of the polarization of the charge exchange, or the rotation of the scattering cross section of the proton–neutron and antiproton–proton charge exchange. The original goal—to clarify all questions on the basis of a single pole—has been reached some time ago. It became obvious that there is a pole corresponding to each of the elementary particles; thus contribution of several poles may be evaluated for the case of elastic scattering if it is assumed that the coefficients are identical. The present state of the theory is examined critically from the viewpoint of high energy problems, inelastic scattering phenomena and the quasi-elastic scattering of pseudoscalar meson–baryon systems. (TTT)

5597 BOOTSTRAPS, FIELDS, AND GENERALISED GROUPS. Taylor, John G. (Mathematical Inst., Oxford). pp 221-68 of Quantum Theory and Statistical Physics. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

A field theory of bootstraps is formulated and some of the mathematical problems arising in such a theory are briefly discussed. As an introduction a survey is given of the theory and results of the N/D approach to bootstraps. A field theory for composites is first formulated; the classification of particles as composites is then considered. Generalized groups for constructing bootstraps are also discussed. (L.B.S.)

5598 ELEMENTARY APPROACH TO DAUGHTERS AND CONSPIRACY. de Alfaro, V. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin); Rossetti, C.; Kuo, P. K.; Rebbi, C. Nuovo Cim., 58A: 87-99(Nov. 1, 1968).

An elementary theory is presented of the constraint phenomena which appear in the Regge representation framework in a particular kinematical configuration. The single assumption is that, when the four-vector Δ_μ tends to zero, the value of an amplitude must be independent of the direction along which $\Delta_\mu \rightarrow 0$, as is taught by the Feynman amplitudes. This statement is applied to scalar particle scattering, and to π-N and pseudoscalar-vector scattering, deriving quite simply the so-called daughter and conspiratory phenomena. (auth)

5599 STRONG DECAYS OF RESONANCES AND COUPLING CONSTANTS. Carbone, G. (Univ., Turin). Nuovo Cim., 58A: 23-33(Nov. 1, 1968).

The "contracted projectors" method is used in order to obtain simple expressions for the coupling constants of some classes of strong decays. Numerical values of these coupling constants are then calculated by means of the available experimental data. (auth)

5600 BOOTSTRAP PRINCIPLE AND EQUAL-TIME COMMUTATORS. Chapline, G. Jr. (Univ. of California, Santa Cruz). Nuovo Cim., 58A: 1-6(Nov. 1, 1968).

Implications of the bootstrap principle for equal-time commutators of hadron-current operators are discussed. It is shown that current algebra is closely related to bootstrap theory. (auth)

5601 DOUBLE-PEAKED STRUCTURE IN RESONANCE SCATTERING. Fujii, Y.; Kato, M. (Tokyo Univ.). Nuovo Cim., 58A: 297-300(Nov. 1, 1968).

In connection with a recently reported double-peaked structure of the A_2-meson, a possible type of resonance scattering was suggested by Coulter and Shaw in which a dip in the inelastic factor η (i.e., a peak in the inelastic cross section) is associated with two peaks in the elastic and total cross sections. A simple scattering amplitude with two poles in the complex s-plane is investi-

gated, and it is shown that the peculiar phenomena occur when these poles have almost the same real parts. (L.B.S.)

5602 ABSORPTION CORRECTIONS FOR THE DOUBLE PERIPHERAL MODEL. Schonfelder, J. L. (Imperial Coll. of Science and Tech., London). Nuovo Cim., 58A: 221-33(Nov. 1, 1968).

Using the Bethe-Salpeter equation as a starting point, it is shown that the normal peripheral model with absorption corrections for quasi-two-particle scattering can be derived with plausible high-energy approximations. It is then shown that essentially the same approximations, applied to the Bethe-Salpeter equation for single-particle-production reactions, yield a formula for correcting the double peripheral model for absorption. These absorption formulas are then written in the overlap integral form, which is suitable for numerical evaluation. (auth)

5603 DERIVATION OF THE MASS AND SPIN SPECTRUM FOR MESONS AND BARYONS. Boehm, A. (Syracuse Univ., N. Y.). Phys. Rev., 175: 1767-73(Nov. 25, 1968).

The problem of classification and mass spectrum of elementary particles is considered in the framework of the algebraic approach. It is shown that mesons as well as baryons can be described by one and the same algebra, which is essentially a combination of the Majorana representation and the de Sitter model, and that the spectrum can be derived with the use of only one new constant. (auth)

5604 MODEL OF HIGH-ENERGY ELASTIC SCATTERING AND DIFFRACTIVE EXCITATION PROCESSES IN HADRON–HADRON COLLISIONS. Chou, T. T.; Yang, C. N. (State Univ. of New York, Stony Brook). Phys. Rev., 175: 1832-4(Nov. 25, 1968).

q Numbers are introduced to replace c numbers for the density function ρ in a recent model of high-energy elastic scattering. The result is shown to be equivalent to the Glauber theory suitably generalized. The model leads naturally to the distinction between diffractive and nondiffractive excitation processes. The former has finite cross sections at infinite energy. Selection and intensities rules for diffractive excitation processes are discussed. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 5595 and 5703.

5605 REGGE-POLE MODEL OF THE pn AND $\bar{p}p$ CHARGE-EXCHANGE SCATTERINGS. Fukui, Ichio; Morita, Katsusada (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 40: 538-49(Sept. 1968).

A phenomenological Regge-pole model which describes the pn and $\bar{p}p$ charge-exchange scattering at high energies and for momentum transfers up to -1 $(GeV/c)^2$ is presented. The well-known narrow forward peak which is seen in the pn charge-exchange is reproduced by using pion's conspiracy. The large difference of the differential cross sections for the two reactions can be explained by assuming a large contribution of the B trajectory. All the residue functions have exponents of $0.5 \sim 2.5$ $(GeV/c)^{-2}$. Polarization parameters for the two reactions are calculated, which show a characteristic behavior near the forward direction and would provide one of critical tests of pion's conspiracy model. (auth)

5606 QUARK MODEL FOR THE PRODUCTION OF PSEUDOSCALAR MESONS IN ANNIHILATION. Patera, J.; Simak, V. (Inst. of Physics, Prague). Czech. J. Phys., 18: 1357-64(1968).

A modification of the quark model for annihilation permits the calculation of the relative probabilities of all observed channels with pseudoscalar mesons. Agreement with the experimental data on proton–antiproton annihilations at rest into three and more mesons is obtained. (auth)

5607 ANTIPROTON–PROTON ANNIHILATION AT REST. Frenkel, Andor (Central Research Inst. for Physics, Budapest). Magy. Fiz. Foly., 16: 387-400(1968). (In Hungarian).

The intensive experimental studies on the antiproton–nucleon ($\bar{N}N$) annihilation are reviewed, examining the $\bar{p}N$ and in particular the $\bar{p}p$ annihilations at rest. On the basis of the selection rules, based on the charge and pulse parity conservation rules of strong electromagnetic interactions, it was possible to derive the forbidden states. Calculations revealed the dominance of the S wave in the $\bar{p}p$ annihilations at rest. Most of the pertinent experimental work was carried out at Columbia University and at CERN with hydrogen-filled bubble chambers. It was not possible to detect π^0 and K_2 mesons; their presence was calculated from the mass difference. In the annihilation process η, ω, ρ, and K^* resonances were observed, together with certain higher resonances, such as B, A_1, A_2, etc. Thus, the final state of annihilation which may be reached directly only through the resonance states, contains only π and K mesons. The attempts to develop a theory of $\bar{N}N$ annihilations by means of higher symmetries, the quark model, and the statistical model were outlined (Review article, 72 references). (TTT)

5608 UNIFIED FIELD THEORY OF ELEMENTARY PARTICLES. I. THEORY OF PSEUDOSCALAR MESONS. van der Merwe, P. du T. (Atomic Energy Board, Pelindaba, India). Nuovo Cim., 58A: 171-90(Nov. 1, 1968).

The unified field theory of Heisenberg and co-workers is considered in the framework of Bethe-Salpeter dynamics. The approach suggests, in contrast to the Tamm-Dancoff formulations, the use of a Green's function involving the baryon mass, in order to rectify deficiencies in the analytic properties of solutions hitherto found. On the basis of a noncanonical quantization procedure, the theory predicts the existence of two families of spin-parity 0^- mesons, a) a strongly bound family of solutions: a pion triplet, an eta singlet and kaon doublets, supporting previous results of the unified field theory, and b) a new family of nearly degenerate mesons in the proximity of the baryon mass. The dynamical theory of the mutual baryon-baryon coupling constants to the pseudoscalar mesons is presented. The results are compared to experiment where available. It is pointed out that the dynamical solutions possess super-conducting properties. In particular, the dynamical results for the pseudoscalar meson masses can be interpreted in analogy to the gap equations which arise in many-body fermion systems. (auth)

5609 NEW RIGOROUS INEQUALITY ON THE $\pi^0\pi^0 \to \pi^0\pi^0$ s-WAVE AMPLITUDE. Martin, A. (CERN, Geneva). Nuovo Cim., 58A: 303-5(Nov. 1, 1968).

A new rigorous inequality on the $\pi^0\pi^0$ scattering amplitude is derived which is more stringent than those which were previously obtained from axiomatic analyticity and positive properties of the absorptive parts in all channels. (L.B.S.)

5610 COMPOSITENESS CONDITIONS FOR VECTOR PARTICLES. Ciccariello, S. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua); Tonin, M.; Sartori, G. Nuovo Cim., 58A: 43-58(Nov. 1, 1968).

It is shown that the conditions which must be satisfied in order that a vector particle, interacting with a spin-$\frac{1}{2}$ particle-antiparticle system, becomes a composite one, are exactly the same as those found for scalar particles by several authors. (auth)

5611 REGGE TRAJECTORIES AND RESIDUES IN THE QUARK MODEL. Squires, E. J. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim., 58A: 7-22(Nov. 1, 1968).

A relativistic quark model of mesons is considered. It is shown that the slopes and positions of Regge trajectories imply curious constraints on the input forces of the N/D method. One of two possible general forms for these constraints gives a natural explanation of the linearity of trajectories over a large range of s, but leads to residues which vary too rapidly with energy to accord with experimental data. For the Pomeranchukon, however, an approximately constant residue appears most natural—again in violation of experimental evidence. If the model has any relevance to physics it therefore supports the idea that high-energy elastic scattering is not dominated simply by a Regge pole. (auth)

5612 EFFECTIVE TRAJECTORIES IN THE PRESENCE OF REGGE CUTS. Rivers, R. J. (Imperial Coll. of Science and Tech., London). Nuovo Cim., 58A: 100-13(Nov. 1, 1968).

Given a Regge pole A with trajectory $\alpha_A(t)$ an energy-dependent effective trajectory $\alpha_A^{eff}(t;s)$ is defined that takes into account the important Regge cuts. It is estimated that $\alpha_A^{eff}(t;s)$ approaches the asymptotic effective leading trajectory $\bar{\alpha}_A(t)$ (the envelope of $\alpha_A(t)$ and its P-cut branch points) slowly as a function of s. An explicit calculation of α_ρ^{eff} is made for the simple case of $\pi\pi$-scattering in the Reggeized absorption model taking the ρ, P, P′ trajectories to be linear. It is shown that for $-t \lesssim 0.3$ $(GeV)^2$ $\alpha_\rho^{eff} \approx \alpha_\rho$ and for $-t \gtrsim 0.6$ $(GeV)^2$ $\alpha_\rho^{eff} \approx \bar{\alpha}_\rho$. The intermediate range is characterized by a dip and a peak due to destructive interference between the cut and pole amplitudes. The sensitivity of the conclusion to the unknown or ill-determined parameters is discussed. (auth)

5613 STUDY OF $\pi\pi$ ELASTIC SCATTERING USING THE CHEW-LOW EXTRAPOLATION METHOD. Marateck, S. (Univ. of Pennsylvania, Philadelphia); Hagopian, V.; Selove, W.; (and others). Phys. Lett., 21: 1613-17(Dec. 2, 1968).

The cross sections for $\pi^-\pi^0$ and $\pi^-\pi^+$ elastic scattering, and the I = 0 s-wave and I = 1 p-wave phase shifts, δ_0^0 and δ_1, are calculated for $400 < M_{\pi\pi} < 900$ MeV using a Chew-Low extrapolation. The extrapolation information permits resolving a fourfold ambiguity which has been present in other attempts to determine δ_0^0 from the reaction $\pi^-p \to \pi^+\pi^-n$. The result for δ_0^0 is consistent

with a curve which increases through 90° around $M_{\pi\pi} = 720$. The ρ width obtained from the extrapolated p-wave amplitude is 105 ± 15 MeV. (auth)

5614 METHOD OF POLE DOMINANCE AND APPLICATIONS. Schwarz, John H. (Princeton Univ., N. J.). Phys. Rev., 175: 1852-64(Nov. 25, 1968).

A method for calculating scattering amplitudes at low to moderate energies in terms of their bound-state and resonant poles is presented. By comparing expressions obtained for s-wave scattering lengths with corresponding predictions of current algebra, the widths of the ρ, K*, Δ, and ω resonances are calculated in close agreement with experiment. Furthermore, without reference to current algebra, all the detailed features of πN elastic scattering (such as the behavior of the P_{11} phase shift) up to an energy of 400 MeV are obtained within an error of about 10 to 20%. The principal advantage of the present method over previous pole-dominance models is that the calculation of amplitudes has been reduced to the evaluation of a number of rapidly convergent integrals. In some cases, one or two undetermined subtraction constants must be introduced, but in the examples of πK and πN elastic scattering only one unknown constant arises, and it can be evaluated by means of the Adler self-consistency condition or an M = 1 O(4) assignment for the pion. (auth)

5615 PION PHOTOPRODUCTION, NN SCATTERING, AND PHOTOPRODUCTION SUM RULES. Brower, Richard C.; Dash, Jan W. (Univ. of California, Berkeley). Phys. Rev., 175: 2014-24(Nov. 25, 1968).

The differential cross sections for pion photoproduction were examined along with those for $pn \to np$ and $p\bar{p} \to n\bar{n}$ scattering. It is found that an M = 1 pion parity-doublet fit is consistent with both sets of data if a full dynamical zero in the $N\bar{N}\pi$ vertex function is hypothesized. If a square-root-type dynamical zero is postulated, some problems with consistency between fits arise. In the former case, the zero is at $t_0 \approx -0.05$ GeV^2. In both fits the M = 0 ρ, A_2, and B trajectories are introduced. The possibility of an M = 1 parity-doublet-type conspiracy for the B trajectory was also investigated qualitatively. This assignment is suggested by a B-trajectory photoproduction finite-energy sum rule and by consistency requirements between phenomenological fits and the Bietti-Roy-Chu pion-photoproduction sum rule which predicts $t_0 \approx -0.03$ GeV^2. Additional experimental tests for an M = 1 B trajectory are proposed. (auth)

5616 APPLICATION OF HARD-PION FOUR-POINT FUNCTIONS TO PION–PION SCATTERING. Arnowitt, R.; Friedman, M. H.; Nath, P.; Suitor, R. (Northeastern Univ., Boston). Phys. Rev., 175: 1820-31(Nov. 25, 1968).

Application of hard-pion four-point functions is made to $\pi\pi$ scattering on the basis of the SU(2) × SU(2) current algebra, a conserved vector current, a partially conserved axial-vector current, and the hypothesis of single-meson dominance of intermediate states in T products. The calculation uses techniques previously developed for exploiting the content of the current algebra and the subsidiary conditions for an N-point process. The $\pi\pi$ scattering amplitude is shown to include, besides the well-known pole diagrams, a set of seagull terms. The Weinberg scattering lengths and effective ranges are found to be accurate to within a few percent, since the hard-pion corrections at threshold are only of $O(m_\pi^2/m_\rho^2)$. In the low-energy region, the scattering-phase shifts are seen to be generally small and essentially model-independent, while at the K-meson mass we find $\delta_0^0 - \delta_0^2 \simeq 35°$. All existing data (up to 1 GeV) can be fitted by adjusting one model-dependent parameter. (auth)

5617 HARD-PION CURRENT-ALGEBRA CALCULATION OF MESON PROCESSES: N-POINT FUNCTIONS. Arnowitt, R.; Friedman, M. H.; Nath, P.; Suitor, R. (Northeastern Univ., Boston). Phys. Rev., 175: 1802-19(Nov. 25, 1968).

Hard-pion techniques are presented for calculating T products of an arbitrary number of vector and axial-vector currents under the assumptions of single σ-, π-, ρ-, and A_1-meson saturation of intermediate sums, chiral SU(2) × SU(2)-algebra commutation relations, conservation of vector current (CVC), and partial conservation of axial-vector current (PCAC). The single-meson dominance hypothesis is shown to imply that one calculates the T products, keeping only certain generalized tree and seagull diagrams. Alternatively, the assumption can be replaced by requiring that one calculate with an "effective" interaction Lagrangian L_I to lowest nonvanishing order. The conditions that the remaining hypotheses (current commutation relations, CVC, and PCAC) impose on L_I are expressed in terms of functional differential equations to determine the form of L_I. These equations are shown to be consistent with each other and may in fact be integrated order by order. The L_I needed to calculate any four-point function is given explicitly. (auth)

5618 NUCLEON AND PION FORM FACTORS AND THE DIPOLE ρ MESON. Kreps, R. E.; Moffat, J. W. (Univ. of Toronto). Phys. Rev., 175: 1945-7(Nov. 25, 1968).

A model of the pion and nucleon form factors is studied in which the isoscalar nucleon form factor is dominated by monopole ω and ϕ mesons, and the isovector form factor by a dipole ρ meson. The predicted form factors are in good agreement with the data. The experimental ρ-, ω-, and ϕ-meson masses and the nucleon magnetic moments constitute the only numerical input in the model. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 5595, 5613, 5614, and 5618.

5619 AXIAL-VECTOR-MESON PRODUCTION IN THE REGGE-POLE MODEL. Young, Bing-lin (Indiana Univ., Bloomington). Nuovo Cim., 58A: 340-64(Nov. 21, 1968).

The differential cross-sections for the production of the axial vector mesons in the $\pi^\pm p$ and $K^+ p$ collisions are given in the Regge-pole model. The kinematic singularities and constraints of the helicity amplitudes of these reactions are investigated by means of general methods. From the vanishing of the cross-section of $K^- + p \to \overline{K}^0_A + n$, it is suggested that either the couplings of the axial vector meson and pseudoscalar meson to the tensor meson or vector meson are small, or the contributions of A_2 and ρ cancel each other at all values of the momentum transfer. It is also argued that the contributions of the axial vector mesons to the production of themselves are small. (auth)

5620 PION CREATION AND QUARK PHENOMENOLOGY. Winzeler, H. (Univ., Amsterdam). Nucl. Phys., B7: 625-34(1968).

Pion creation cross sections for processes of the type x + p → x + nucleon + nπ are given for p, π, K, and $\bar{p}$ as incoming particles. Following a slightly modified version of a method introduced by Satz, the applicability of the additive quark picture and of the assumption of isospin independence of cross section to K and $\bar{p}$ is discussed. (auth)

5621 TEST OF ABSORPTION-MODEL PREDICTIONS IN DOUBLE RESONANCE PRODUCTION BY 5 GeV/c π^+ MESONS ON PROTONS. Boeckmann, K. (Univ., Bonn. Kernforschungsanlange, Juelich, Ger.); Rost, M.; Sternberger, K. (and others). Nucl. Phys., B7: 681-9(1968).

The joint-decay density matrices for $\pi^+ p \to N^{*++}\rho^0$ and $\pi^+ p \to N^{*++}\omega^0$ are presented as functions of $|t\text{-}t_{min}|$ and compared with the absorption model predictions. For the N*ρ channel a satisfactory over-all agreement with the predictions of the one-pion exchange absorption model is observed. For the N*ω channel however, the data show substantial disagreement with the absorption-model predictions for ρ-meson exchange assuming a magnetic dipole type coupling of the ρ-meson to the nucleon. (auth)

5622 DETERMINATION OF PION–BARYON COUPLING CONSTANTS. Chan, C. H.; Meiere, F. T. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1428. Phys. Lett., 28B: 125-7(Nov. 11, 1968).

The same experimental information used to determine the KNY coupling constants is used to determine the $\pi\Sigma\Lambda$ and $\pi\Sigma\Sigma$ coupling constants. The results do not agree with exact SU(3) symmetry. (auth)

5623 REGGE MODEL FOR PRODUCTION OF AXIAL VECTOR MESONS IN PION–NUCLEON COLLISIONS. Altarelli, G. (Univ., Florence); Gatto, R.; Maiani, L. Nuovo Cim., 58A: 259-88(Nov. 1, 1968).

The reactions pseudoscalar + nucleon → axial + nucleon and pseudoscalar + nucleon → axial + $\frac{3}{2}^+$-resonance, are discussed. The general Regge-pole formalism is first developed in detail. It is subsequently specialized in the following steps: i) production near the forward direction, ii) validity of SU_3 (with breakings for meson mixings); iii) validity of exchange degeneracy. Two nonets of produced axial mesons are considered: the A-nonet ($J^{PC} = 1^{++}$) and the B-nonet ($J^{PC} = 1^{+-}$); and the effects of the possible A-B mixings are examined. The most specific model, assuming SU_3 and exchange degeneracy, gives rise to a large number of restrictions (mostly inequalities) among cross-sections which should be testable. The value of D/F for the couplings of the R-trajectories to nucleons is a relevant unknown parameter; its value is calculated in the kinetic supermultiplet model for a possible indication. The problem of K_A-K_B interference is discussed and the implied shape of the K* mass spectra is examined. (auth)

5624 NUMERICAL ESTIMATE OF THE CONSISTENCY CONDITION FOR $\pi^- p \to N^{*-}\pi^+$. Singh, C. P.; Agarwal, B. K. (Allahabad Univ., India). Nuovo Cim., 58A: 306-7(Nov. 1, 1968).

A test is made of the Adler-type consistency condition previously obtained on the amplitude for the $\pi^- + p \to N^{*-} + \pi^+$ interac-

tion. The single-variable dispersion integral for the amplitude is saturated with the low lying intermediate states in the zero-width approximation. A numerical estimate is obtained which shows that the consistency condition is reasonably satisfied. (L.B.S.)

5625 RELATIVISTIC SCHROEDINGER EQUATION AND ITS APPLICATION TO PSEUDOSCALAR MESON–BARYON SCATTERING IN A BROKEN SU_3 SYMMETRY MODEL. Katz, J. (Univ. of Illinois, Urbana). Nuovo Cim., 58A: 125-44(Nov. 1, 1968).

The relativistic Schrödinger equation is applied to the multichannel problem of pseudoscalar meson-baryon scattering in the two lowest partial waves. Actual physical masses are used in the calculation so that SU_3 symmetry is broken. The potential is obtained by computing allowed single-particle exchange processes for which the exchanged particles have spin less than or equal to $\frac{3}{2}$, following some simple rules. The model accounts for most of the experimentally known baryon resonances in these partial waves. (auth)

5626 CHARGE EXCHANGE SCATTERING USING SU(3) SYMMETRY AND REGGE POLES. Khanam, Farkhanda; Harun Ar-Rashid, A. M. (Univ. of Islamabad, Rawalpindi, Pakistan). J. Natur. Sci. Math., 8: 17-22(Apr. 1968).

On the basis of SU_3 symmetry and Regge trajectory exchange in the t-channel, meson baryon charge exchange scattering has been studied. The differential cross-sections in the forward direction can be predicted reasonably well in this simple model. (auth)

5627 DECAYS OF NEGATIVE-PARITY BARYONS IN A QUARK MODEL. Divgi, D. R. (Univ. of Maryland, College Park). Phys. Rev., 175: 2027-9(Nov. 25, 1968).

Decay widths for baryons in the $(70,1^-)$ supermultiplet are calculated using the symmetric quark model. Mixings are taken into account. The branching ratio $[Y_1^*(1519) \to N\bar{K}]/[Y_1^*(1519) \to \Sigma\pi]$ shows that even a small mixing angle can be important. (auth)

5628 REANALYSIS OF THE LOWEST-MASS NEGATIVE-PARITY BARYON RESONANCES USING THE SYMMETRIC QUARK MODEL. Divgi, D. R.; Greenberg, O. W. (Univ. of Maryland, College Park). Phys. Rev., 175: 2024-6(Nov. 25, 1968).

The lowest-mass negative-parity baryon resonances are reanalyzed using a systematic SU(6) analysis of mass operators developed earlier in the symmetric quark model. Fourteen resonances with known spin and parity are fitted to within 15 MeV on the average, using a six-parameter mass formula. Strong mixings are found for $J^P = \frac{1}{2}^-$ and $\frac{3}{2}^-$ resonances, and thus the Gell–Mann-Okubo mass formula cannot be expected to hold for these resonances, and there is no sense in trying to group them into octets and decuplets. (auth)

5629 s-WAVE K^+p DYNAMICS. Martin, B. R. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 175: 2034-7 (Nov. 25, 1968).

An investigation of the dynamics of low-energy s-wave K^+p scattering was made by the semiphenomenological application of dispersion relations. Contributions to the s-wave K^+p dispersion relation from the nearby singularities due to the following processes were explicitly calculated: (a) exchange of Λ and Σ in the u channel; (b) exchange of ρ, ω, and ϕ in the t channel, treated in the narrow-width approximation; and (c) exchange of an s-wave $T = 0$ π-π pair, treated as a continuum state. Other exchanges, and short-range forces, were treated phenomenologically. The amplitude of the physical region was taken from a recent phase-shift analysis of K^+p scattering data, and the necessary coupling constants for the exchange processes were obtained from experiment, supplemented by the use of SU(3) symmetry when experimental data were not available. The exchange of the s wave $T = 0$ π-π pair is shown to be potentially a very important term, and the present difficulties in calculating its exact size are discussed in detail. (auth)

5630 LORENTZ-POLE MODEL AND POLARIZATION IN HIGH-ENERGY CHARGE-EXCHANGE PION–NUCLEON SCATTERING. Antoniou, N. G.; Komy, S. R.; Palev, C. D.; Samiullah, M. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., 175: 1757-61(Nov. 25, 1968).

A mechanism is proposed for explaining the polarization in high-energy charge-exchange πN scattering, based on O(3,1) partial-wave analysis. It is found that the nonvanishing polarization may be understood in terms of one Lorentz pole, $\sigma_\rho = \alpha_\rho + 1$, and that it is due to the interference of ρ with another Regge pole ρ' belonging to the family $j_0 = 0$ and given in terms of σ_ρ by the relation $\alpha_{\rho'} = \sigma_\rho - 2$. (auth)

5631 ANALYTICITY AND BROKEN SL(2,C) SYMMETRY FOR REGGE FAMILIES. Kuo, P. K.; Walker, James F. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 175: 1794-1801(Nov. 25, 1968).

Explicit constraints on the mass dependence of daughter Regge trajectories, near zero mass, are obtained for fermion trajectories contributing to πN scattering. Both the analyticity and the group-theoretic approaches are investigated. Agreement is found between these two methods, but disagreement is found between the constraints and those previously published. For the dependence on the mass W of the kth daughter trajectory with parity designation $\pm$, it is found that $\alpha_k^{(\pm)}(W) = \sigma - k \pm A(\sigma - k + \frac{1}{2})W + [B_1 + B_2(\sigma - k)(\sigma - k + 1) + A^2(\sigma - k + \frac{1}{2})]W^2 \pm \ldots$, where σ, A, B_1, and B_2 are constants over the family. For each of the two methods, the assumptions leading to the MacDowell symmetry evident above are stressed. (auth)

5632 REGGE POLES AND FINITE-ENERGY SUM RULES FOR KAON–NUCLEON SCATTERING. Dass, Guru Vachan (Atomic Energy Research Establishment, Harwell, Eng. Rutherford Lab., Chilton, Eng.); Michael, C. Phys. Rev., 175: 1774-94(Nov. 25, 1968).

Generalized finite-energy sum rules (FESR) for kaon-nucleon scattering are evaluated to determine the t dependence and other properties of the relevant Regge-exchange amplitudes: P, P′, A_2, ρ, and ω. The FESR's have been evaluated (a) with the available phase-shift analyses for the low-energy KN system as input and (b) in the resonance-saturation approximation with all the appropriate resonances of which J^P is known. For the K^+p system, the phase-shift analysis of Lea et al. has been used; for the $\bar{K}N$ system, the multichannel effective-range analysis of Kim, and the resonance-plus-background analysis of Armenteros et al. Matching energies of $\sqrt{s} = 2$ GeV and $\sqrt{s} = 2.15$ GeV have been used for the cases (a) and (b), respectively. In terms of the definite helicity flip amplitudes, A (which is the full forward amplitude at $t = 0$) and B, it is found that assuming the ρ contribution to be known, the non-spin-flip contributions for the various Regge poles are similar to those deduced from high-energy fits; however, the spin-flip contributions of the high-energy fits are inconsistent with our FESR results. For example, the factorization ratio $(\nu B/A)$ for the A_2, P, P′, and ω contributions, where ν is (s-u)/4M, is found to have the opposite sign to that used in previous high-energy fits. As far as the results go, the FESR's are consistent with the usual explanation of the crossover phenomenon in terms of a single genuine ω Regge pole, though this conclusion cannot be regarded as very strong, because of the poor available input data. No evidence is found of a wrong-signature nonsense zero in α_ω for $-t \lesssim 0.8$ $(\text{GeV}/c)^2$; it is found that $(\nu B/A)_\omega = +(1\text{-}3)$ for $-t \lesssim 0.6$ $(\text{GeV}/c)^2$. There is some evidence for an exchange degeneracy between the ω and the P′ for this ratio, because evidence is also found for $(\nu B/A)_{P,P'} \approx +1$. There is some evidence for the no-compensation mechanism for the P′, with $\alpha_{P'} = 0$ at $-t \sim 0.5$ $(\text{GeV}/c)^2$, which, however, would make the ω and P′ trajectories quite nondegenerate. For the A_2, it is found that $\nu B/A \sim +10$, which would be expected if the A_2 were degenerate with the ρ. The determination of the signs of the spin-flip amplitudes B allows the K^+p polarizations to be predicted semiquantitatively; the results agree with the available K^-p polarization data, while the previous Regge models gave the wrong sign of this polarization. The new signs for the B amplitudes also improve the agreement of the conventional Regge model with the available K^+n charge-exchange cross section without invoking a ρ' contribution. On the basis of getting good agreement between the FESR results and the Regge expectations, a particular set of low-energy input data is chosen as our favored one: Kim's coupling constants g_{NA}^2 and $g_{N\Sigma}^2$ for the Born terms, a negligible $Y_1^*(1385)$ coupling (as also found by Kim), and the nonresonant-type solution IV for the K^+p phase-shift analysis. The FESR's for amplitudes with the wrong crossing properties were also considered, generalizing the Schwarz superconvergence relations. A simple model to remove the infinities expected in the case of Schwarz FESR's is seen to be in good agreement with the low-energy data, at least at $t = 0$. (auth)

5633 PION–NUCLEON ELASTIC SCATTERING ABOVE 1 GeV. Rost, E.; Libby, L. Marshall (Univ. of Colorado, Boulder). Contract AT(11-1)-1537. Phys. Rev., 175: 1869-72(Nov. 25, 1968).

The diffraction part of the pion-nucleon elastic scattering is described by the Dirac equation, using an absorptive central potential with a hard core. Cross-section and polarization data for pion-proton elastic scattering in the 1.7 to 18.4-GeV/c region are fitted with three parameters — a potential strength, range, and core radius. The range and core radius are commensurable with values found in other elementary-particle systems. (auth)

5634 PREDICTION FOR THE REACTION $\pi N \to \pi N^*$ BASED ON A PARTIALLY CONSERVED AXIAL-VECTOR CURRENT. Arons, M. E. (City Univ. of New York, N. Y.). Phys. Rev., 175: 1905-11(Nov. 25, 1968).

Using the hypothesis of PCAC, the threshold amplitude for the isobar production reaction $\pi N \to \pi N^*$ is calculated. Since the result depends on strong-interaction quantities alone and does not

rely on current-algebra assumptions, it is the analog of Adler's consistency condition for elastic πN scattering. Although the experimental situation is not clear-cut, a comparison of the prediction with experiment provides tentative support for the validity of the PCAC hypothesis. (auth)

5635 REGGE-POLE MODEL WITH THE M = 1 PION IN $\pi^+p \to \rho^0\Delta^{++}$ AND $\pi^+p \to \rho^+p$ SCATTERING. Arbab, Farzam; Brower, Richard C. (Univ. of California, Berkeley). Phys. Rev., 175: 1991-7(Nov. 25, 1968).

For $\rho\Delta$ production the main amplitude of an M = 1 pion vanishes at t = 0, and for ρ production the M = 1 pion has a zero in the physical region near $|t| = t_0$ of the order of m_π^2 in the $N\bar{N}$ vertex. The sharp peak of the $\rho\Delta$ production data at 8 GeV/c is fitted with the M = 1 pion interfering with the A_1. Pseudothreshold relations at $t = (m_\Delta - m_N)^2$ are essential to this fit. Even better fits are obtained with a square-root zero in all vertices involving the pion at t_0, as assumed in the early np charge-exchange fits. A fit to the ρ production data at 8, 4.2, and 2.75 GeV/c is also achieved with this model. Here the daughter of the A_1 serves to compensate for the zero in the $\pi N\bar{N}$ vertex. In both reactions, to limit the number of free parameters, only t-channel amplitudes are considered for the zero-helicity ρ by fitting $\rho_{00}(d\sigma/dt)$. (auth)

5636 DIPOLE ρ MESON, NUCLEON FORM FACTORS, AND CHARGE-EXCHANGE SCATTERING. Kreps, R. E.; Moffat, J. W. (Univ. of Toronto). Phys. Rev., 175: 1942-4(Nov. 25, 1968).

On the basis of a dipole model of the ρ meson, the $1/q^4$ behavior of the nucleon form factor is explained. In terms of an extension of Regge-pole ideas to a dipole ρ trajectory, fits are obtained to the charge-exchange cross sections, and a nonzero polarization is predicted. (auth)

5637 PUZZLE OF REGGE DIPS. Roskies, Ralph (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 175: 1933-41(Nov. 25, 1968).

The formalism giving rise to Regge dips is reviewed, and the modifications due to singular residues are discussed. The πN charge-exchange reaction is parametrized to allow for a singular ρ residue as α_ρ passes through zero, but the fits show that the singularity is very weak. A model of a singular residue is presented, and it is argued that perturbation-theory models are at variance with the experimentally observed behavior of the ρ residue. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 5528, 5615, and 5699.

5638 (CALT-68-173) REGGE CUT CORRECTIONS TO REGGE POLE EXCHANGE. Frautschi, Steven (California Inst. of Tech., Pasadena). Oct. 1968. Contract AT(11-1)-68. 15p. (CTSL-IR-39). Dep. CFSTI.

It has been believed on theoretical grounds since 1963 that scattering amplitudes have cuts as well as poles in the angular momentum. For reasons of simplicity, the cuts have usually not been incorporated in the phenomenological models used to fit data. Recently, however, Arnold has suggested a prescription which, if accepted, allows one to estimate the cuts from the poles without adding any further parameters. The cuts, thus estimated, provide a natural explanation for such phenomena as the break in pp elastic scattering, the forward spike in np charge exchange and $\gamma p \to \pi^+ n$, and the crossover of differential cross sections for elastic pp and $\bar{p}p$, π^+p and π^-p, etc., whereas each of these phenomena requires extra parameters in models containing only Regge poles. (auth)

5639 CHARGE DEPENDENT EFFECTS OF THE PROTON–PION EXCHANGE PROCESS IN THE N–N INTERACTION. Leung, J. S. (Yale Univ., New Haven); Nogami, Y. Nucl. Phys., B7: 527-44(1968).

Considerable effort has been made to explain the observed charge dependence of the low-energy parameters of the ^1S nucleon–nucleon scattering, as due to various electromagnetic corrections. Noyes has pointed out that the difference between the p-p effective ranges, $r_{pp} - r_{pn} \approx 0.4$ fm, indicated by the experiment of Engelke et al., would imply that the p-p potential is more than 30% more attractive than the p-n potential in the region between 2 and 4 fm and correspondingly less attractive by the same amount at shorter distances. None of the electromagnetic effects so far considered can produce such a long-ranged correction with that strength. However, there is one process which has not been examined and seemed to us to be the only candidate that might result in anything like Noyes' phenomenological correction. This is the photon–pion exchange process, which gives rise to a charge-dependent potential of one-pion range. This photon-pion exchange potential ($\gamma\pi$EP) is evaluated by means of essentially the same technique as that for the two-pion-exchange potential. It turns out that the charge-dependent part of the $\gamma\pi$EP cannot produce the strong charge-dependent correction at large distances required by Noyes' phenomenological analysis. Including the $\gamma\pi$EP, a semiphenomenological analysis of the charge dependence of the scattering parameters is done. It is emphasized that it is futile to attempt to explain the charge-dependent splitting of the scattering length because it is too sensitive to the potential at short distances. Rather, we phenomenologically fix the short-range part of the potential so that the observed splitting of the scattering length is fitted, and then we examine the splitting of the effective range. For the various long-range charge-dependent effects considered, the splitting is found to be $r_{pp} - r_{pn} \approx 0.1$ fm. (auth)

5640 NUCLEAR FORCES WHICH DO NOT CONSERVE PARITY. Shapiro, I. S. (Inst. of Theoretical and Experimental Physics, Moscow). Usp Fiz. Nauk, 95: 647-55(Aug. 1968). (In Russian).

The hypothesis of a universal weak interaction predicts the existence of exchange forces between the proton and neutron, which do not conserve parity, with a constant $G = 10^{-5}/m^2$. Here m is the mass of the nucleon, and $h = c = 1$. With the violation of T-invariance these forces can lead to the appearance of electric dipole moments in hadrons. The weak nucleon flow should be the difference between the polar and axial vectors. The original form of the current is distorted by the strong interaction even in nucleon–lepton processes. In nucleon scattering due to weak forces, the role of strong interactions is even greater, since pion exchange is possible between all particles participating in the process. Of the original "current" hamiltonian of the weak interaction, only two properties survive: the order of magnitude of the binding constant and the isotopic structure. From a mathematical analysis it is possible to define the upper limit of the values of the nuclear factors tending to increase the effects of not conserving parity in nucleon interactions. The theoretical value of a dimensionless parameter F defined by the ratio of the hamiltonians of the weak and strong interactions was found to be 10^{-7} to 10^{-6} by using experimental data on the circular polarization of gamma radiation from ^{181}Ta and ^{175}Lu. (TTT)

5641 FURTHER COMMENTS ON THE DESCRIPTION OF THREE-BODY ASSOCIATED PRODUCTION IN PROTON–PROTON COLLISIONS THROUGH THE ONE-BOSON-EXCHANGE MODEL. Ferrari, E. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome). Phys. Rev., 175: 2003-9(Nov. 25, 1968).

The parameters of the one-boson-exchange model (including pion and kaon exchange), applied in a previous work to the reactions $pp \to YKN$, are re-examined in the light of the results from a recent experiment which presents new data on Σ production. It is found that the cutoff parameters on the momentum transfer in pion exchange must be different for Λ and Σ production. Furthermore, in the former case, the relative amounts of π and K exchange cannot be determined from experiment, provided pion exchange is assumed to be dominant. Finally, a criticism is raised about the existing estimates of resonance production in the above reactions. (auth)

5642 RESONANCE PRODUCTION IN PROTON–PROTON SCATTERING AT 12.5 AND 30 BeV/c. Yen, E. (State Univ. of New York, Stony Brook). Phys. Rev., 175: 1982-91(Nov. 25, 1968).

Recent experiments on proton-proton scattering at high energies reveal the following features: (i) at 12.5 BeV/c, $d^2\sigma/dP^*d\Omega^*$ for outgoing pions and K^+ in the center-of-mass system do not have a maximum at zero longitudinal momentum, but peak at about $P_{\parallel}^* \approx 0.4 - 0.5$ BeV/c and drop rapidly as $P_{\parallel}^* \to 0$ for $P_{\perp}^{*2} = 0.4$ $(\text{BeV/c})^2$; (ii) at 30 BeV/c, the fraction of outgoing protons having "large" momentum ($\geq \frac{1}{2}$ of the c.m. momentum for elastic scattering) in the c.m. system is greater than that of outgoing pions; (iii) at 12.5 BeV/c, there are striking differences between the $d^2\sigma/dP^*d\Omega^*$ for outgoing K^+ and K^- with $P_{\perp}^{*2} = 0.4$ $(\text{BeV/c})^2$ in the c.m. system. It is shown that these features can be understood if it is assumed that resonance production is important. Some other consequences of this assumption are also discussed. With some reasonable assumptions, estimates of the contributions to $(d^2\sigma/dP^*d\Omega^*)(d^2\sigma/dP_{\perp}^* dP_{\parallel}^*)$ for outgoing particles from various resonance production processes are made. Using a simple model for resonance production in proton-proton scattering at 30 BeV/c, good fits are obtained with $d^2\sigma/dP_{\perp}^* dP_{\parallel}^*$ for outgoing π^- and p in the "large" momentum region in the c.m. system. Using a similar model for resonance production in proton-proton scattering at 12.5 BeV/c, good fits are again obtained with $d^2\sigma/dP^*d\Omega^*$ for outgoing pions and K^+ with $P_{\perp}^{*2} = 0.4$ $(\text{BeV/c})^2$. (auth)

5643 HIGH-ENERGY LARGE-ANGLE PROTON–PROTON SCATTERING. Chang, Ngee-pong (City Univ. of New York, N. Y.). Phys. Rev., 175: 1741-8(Nov. 25, 1968).

The impact-parameter representation involving $J_0(kb \sin\vartheta)$

rather than $J_0(2kb \sin\frac{1}{2}\vartheta)$ is used to study high-energy large-angle proton-proton scattering. A model is presented in which the exponential law in $k \sin\vartheta$ holds for large values of $k \sin\vartheta$. This model would thus agree with the Orear fit and, equivalently, for given s, with the CERN fit. An undesirable feature of the theory is that the s-channel Regge poles must retreat to and reside at the negative odd integers for the exponential law to hold. Next an optical model is discussed where the Regge poles are not so constrained. This leads to a power law in $k \sin\vartheta$. For the power law to hold, the requirement is that the Regge poles should be confined to the left half l plane. A complete graphical analysis is presented of present high-energy large-angle data. The power law fits over a wider range of angles than does the exponential law. In this sense, the power law is a better fit. The actual power law approaches an inverse eighth power in $k^2 \sin^2\vartheta$. This agrees with the Wu-Yang suggestion that $d\sigma/d\Omega \propto G_M^4(k^2 \sin^2\vartheta)$, since the nucleon form factor falls off as the inverse square of its argument. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 5597.

5644 (COO-427-82) ZERO-MASS REPRESENTATION OF POINCARE GROUP AND CONFORMAL INVARIANCE. Bose, S. K.; Parker, R. (Notre Dame Univ., Ind. Dept. of Physics). [nd]. 7p. Dep. CFSTI.

By explicit construction it is shown how to extend zero-mass, discrete spin representations of the Poincare group to corresponding representations of the conformal group of Minkowski space. (auth)

5645 (NP-17659) BROKEN SYMMETRY AND ELEMENTARY PARTICLE INTERACTIONS. Gupta, Kiran C. (Delhi Univ. (India)). Oct. 1966. 119p. Dep.

Some aspects of the interactions of the hadrons are treated, both from the group-theoretical and the dispersion-theoretic approaches. A general introduction to the work done is given in Chapter 1. In Chapter 2, the various SU(3)-broken symmetry coupling constants sum rules and the baryon magnetic moments sum rules are derived, assuming the ω-ϕ mixing model. In Chapter 3, using the chiral current algebra, the ω-ϕ mixing parameter is calculated. In Chapter 4, the current algebra technique is used to study the high energy neutrino-nucleon collisions. Finally, in Chapter 5, the Kπ phase shifts are studied using the alternative dynamical approaches — the N/D method and the Regge pole method — to the strong interaction physics. In the Addenda, besides the photostat copies of the papers "Vector-Meson Mixing and Sum Rules in Broken SU(3)," and "T = $\frac{1}{2}$, $\frac{3}{2}$ P and S wave Kπ phase shifts," a reprint of the paper "Neutron Leptonic Decay of Ω^-" is also included, which is an attempt to clarify the roles of $\Delta I = \frac{1}{2}$ and $\Delta Q = \Delta S$ rules for the semi-leptonic weak interactions. (auth)

5646 THE SIXTH INTERACTION: ORIGINS OF THE CP VIOLATION. Nakagawa, Masami (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 40: 677-9(Sept. 1968).

A CP violating interaction is proposed on the basis of the maximal possibility in constructing the elementary particle's interactions in terms of SU_3 currents and intermediate bosons; the CP violation is then simply ascribed to the complex nature of the coupling constants. (L.B.S.)

5647 ON THE REDUCTION OF n-FOLD TENSOR PRODUCT REPRESENTATIONS OF NONCOMPACT GROUPS. Klink, William H.; Smith, Granville J. (Univ. of Iowa, Iowa City). Commun. Math. Phys., 10: 231-44(Oct. 10, 1968).

The reduction of n-fold tensor products of induced unitary representations of noncompact groups into irreducible constituents is shown. Clebsch-Gordon coefficients are then calculated. The technique is applied to the n-fold tensor products of the positive mass representations of the Poincaré group. (auth)

5648 GENERAL THEOREMS ON THE COMBINATION OF RELATIVISTIC AND INTERNAL SYMMETRIES. Berzi, V. (Istituto Nazionale di Fisica Nucleare, Milan). Commun. Math. Phys., 10: 217-30(Oct. 10, 1968).

Theorems about the structure of a Lie algebra combining the Poincaré Lie algebra and an internal symmetry Lie algebra are derived by general algebraic methods. The physical meaning of certain mathematical results is clarified. (auth)

5649 A CONVOLUTION INTEGRAL FOR FOURIER TRANSFORMS ON THE GROUP SL(2,C). Ruehl, W. (CERN, Geneva). Commun. Math. Phys., 10: 199-216(Oct. 10, 1968).

The Fourier transform of a product of two functions on SL(2,C) is expressed as a convolution integral of the Fourier transforms of its factors. With the help of this convolution integral the Fourier transform of a polynomially bounded function is presented as a finite linear combination of analytic delta functionals applied to a continuous function on the real line in an improper sense. (auth)

5650 GAUGE PROPERTIES OF THE GALILEI SPACE. Kastrup, H. A. (Univ., Munich). Nucl. Phys., B7: 545-58(1968).

It is shown that the free nonrelativistic motion is invariant not only under the 10-parameter Galilei group but also under the larger 15-parameter Liouville group, which is isomorphic to the group O(2,4). In addition, there is the usual invariance under time translations and special Galilei transformations. The conserved quantities associated with the new symmetries are given explicitly. Further, it is shown in the case of spin zero that there is a close connection between the unitary representations of the Liouville group and the physical projective representations of the Galilei group. Finally, the consequences of the new conservation laws for interactions, in particular for elastic scattering, are discussed, and it is shown that they impose a vanishing time delay during the interaction. This means that the new exact invariances of the free nonrelativistic particles in general can only be approximate or limiting symmetries for interacting systems. (auth)

5651 CONSEQUENCES OF CPT-INVARIANCE AND EXPERIMENT. Lapidus, L. I. (Joint Inst. of Nuclear Studies, Dubna, USSR). Usp. Fiz. Nauk, 95: 658-68(Aug. 1968). (In Russian).

It is ordinarily assumed that CPT-invariance is an absolute principle of symmetry. At present there is no indication that the confirmation of CP-invariance is connected with the confirmation of T-invariance. In the $K^0-\bar{K}^0$ system the existence of the decay $K_1^0 \to 2\pi$, which contradicts CP-invariance, is an indication of a violation of T-invariance. Thus by means of CPT-invariance it should be possible to carry out indirect confirmation of C, P, or T-invariance in those cases where direct confirmation is not sufficiently accurate. The equivalence of the masses of the lifetimes and of the magnetic moments of particles and their antiparticles shows that there is convincing experimental data supporting the assumption of CPT-invariance in strong, electromagnetic and weak interactions conserving strangeness. The purely weak interactions are also CPT-invariant. From future experiments with K-mesons it will be possible to confirm CPT-invariance with a high degree of accuracy. (TTT)

5652 GROUP THEORETIC APPROACH TO QUANTUM FIELDS. Matthews, P. T. (Imperial Coll. of Science and Tech., London). pp 177-220 of Quantum Theory and Statistical Physics. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

An attempt is made to set up a formalism for relativistic quantum systems which can incorporate simple internal symmetries such as SU(2) or SU(3). From the requirements of relativistic invariance and causality, local causal fields are obtained from which S-matrix elements are constructed. Generalized infinite component fields are considered which are unitary representations of the homogeneous Lorentz group. It is shown that for such fields there is a complete breakdown of the Pauli theorem, which for finite fields establishes, through causality, the experimentally observed connection between spin and statistics. (L.B.S.)

5653 STRUCTURE OF THREE-POINT FUNCTIONS FROM SU(3) ⊗ SU(3) ALGEBRA. Gerstein, Ira S. (Massachusetts Inst. of Tech., Cambridge); Schnitzer, Howard J.; Weinberg, Steven. Contract AT(30-1)-2098. Phys. Rev., 175: 1873-6(Nov. 25, 1968).

Three-point functions of vector and axial-vector currents consistent with the constraints of chiral SU(3) ⊗ SU(3) algebra are constructed. No single-particle approximations are made, nor is it assumed that the strangeness-changing vector currents are conserved. It is, however, assumed that the effects of symmetry breaking may be represented by a set of scalar and pseudoscalar fields transforming as a representation of the algebra. The results are presented in a form in which any approximations will be guaranteed to maintain the constraints of current algebra. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstract 5586.

5654 THE LORENTZ GROUP OVER A FINITE FIELD, AND RELATED PROPERTIES OF DIRAC SPINORS. Beltrametti, Enrico G.; Blasi, Alberto. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 44: 384-90(Mar. 1968). (In Italian).

Some new results in the description of physical schemes within a Galois geometry are reported. The representation of the proper and improper Lorentz groups are examined. Dirac spinors and a form associated with the vector and axial-vector currents are introduced. Topics discussed include rotation and Lorentz groups in a Galois geometry, spinor representations of the extended Lorentz group L(4,p), and covariant currents. (C.E.S.)

5655 VIOLATION OF CP INVARIANCE. Okun, L. B. (Inst. of Theoretical and Experimental Physics, Moscow). Usp. Fiz. Nauk, 95: 402-16(July 1968). (In Russian).

The article is the text of a report read at the Moscow seminar on the violation of CP invariance in January 1968. It contains a brief survey of the main experimental data related to CP, T, and CPT invariance phenomena and a discussion of certain theoretical questions related to these phenomena. (tr-auth)

5656 VIOLATION OF CP-PARITY IN K → 3π DECAYS. Anisovich, V. V. (Inst. of High Energy Physics, Serpukhov, USSR). Usp. Fiz. Nauk, 95: 453-9(July 1968). (In Russian).

The possible effects of the violation of CP invariance in the 3π decays of neutral and charged K mesons are considered. An estimate of the difference of probabilities of the $K^+ \to \pi^+ + \pi^+ + \pi^-$ and $K^- \to \pi^+ + \pi^- + \pi^-$ decays and asymmetry of the π meson spectra in the decay $K_L^0 \to \pi^+ + \pi^- + \pi^0$ in relation to the type of interaction are given. It is shown, in particular, that these quantities critically depend on selection rules for isotopic spin of CP-parity of the interactions, and on the scattering lengths of the π mesons. Experimental data on the verification of CP invariance in decays are given. (tr-auth)

5657 MODELS FOR VIOLATION OF CP INVARIANCE. Arbuzov, B. A. (Inst. of High Energy Physics, Serpukhov, USSR). Usp. Fiz. Nauk, 95: 460-6(July 1968). (In Russian).

The possibility of violation of CP invariance in electromagnetic, medium strong, medium weak, and super weak interactions was considered. The different processes in which CP invariance should be violated according to certain models are enumerated. Numerical estimates of various effects are given. The theoretical predictions are compared with existing experimental data. (tr-auth)

Applications (Strong)

Refer also to abstract 5595.

5658 POLARIZATION EXPERIMENTS TO CHECK T AND CPT INVARIANCE IN NUCLEON–NUCLEON AND NUCLEON–ANTINUCLEON SCATTERING. Bilenkii, S. M.; Lapidus, L. I.; Ryndin, R. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Usp. Fiz. Nauk, 95: 489-97(July 1968). (In Russian).

A survey is given of experimental data on the measurement of the ratio between polarization and asymmetry in elastic pp scattering. Possible experiments to check CPT invariance in elastic scattering of antiprotons by protons were discussed. (tr-auth)

5659 THEORETICAL BASIS FOR THE CPT THEOREM. Fainberg, V. Ya. (Lebedev Inst. of Physics, Moscow). Usp. Fiz. Nauk, 95: 479-88(July 1968). (In Russian).

Theoretical premises necessary for the proof of the CPT theorem are discussed. It is shown that the main requirement is the premise concerning the weak local commutative property. Methods of proof of the CPT theorem within the framework of the axiomatic and Lagrangian approach to the theory of elementary particles are compared. It is shown that CPT invariance leads to the coupling of spin and statistics. The possibility of extension of CPT and other symmetries to cases of unstable particle is briefly considered. (tr-auth)

5660 OCTET COUPLING SUM RULES IN A SIMPLE MODEL OF SU(3)-SYMMETRY BREAKING. Dobson, Peter N. Jr. (Univ. of Hawaii, Honolulu). Phys. Rev. Lett., 21: 1658-61(Dec. 9, 1968).

Sum rules for baryon-resonance octet coupling constants are derived from a model of SU(3)-symmetry breaking suggested by Pakvasa. The available data on $\frac{1}{2}^-$, $\frac{3}{2}^-$, $\frac{3}{2}^-$, $\frac{1}{2}^-$, and $\frac{3}{2}^+$ octet states is shown to be compatible with the sum rules. (auth)

5661 ON THE APPROXIMATE C_γ INVARIANCE OF THE PHYSICAL HADRONS. Weiner, Richard M. Rev. Roum. Phys., 13: 291-2(1967).

It is pointed out that the conclusion reached by Horwitz and Neeman (Phys. Letters, 22: 649 (1966)) does not follow necessarily from their model and the existence of counterparticles with masses different from particles is only a sufficient condition for the approximate C_γ invariance. It is also pointed out it is highly improbable that counterparticles have masses different from those of particles. (L.B.S.)

Field Theories

General

5662 CLASSICAL FIELDS AND GRAVITATION. Garber, Vitalij; Coulter, C. A. (Army Missile Command, Redstone Arsenal, Ala.). pp 97-138 of Topics in Fields and Solids. Coulter, C. Alton; Shatas, Romas A. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

Graduate-level lectures given at the 1964 summer seminar in theoretical physics at Redstone Arsenal dealing with classical field theory and gravitation are presented. The discussion begins with consideration of the Lagrangian formalism in four-dimensional space-time. Hamilton's principle is applied to obtain the Euler-Lagrange equations of motion. Criteria for Lorentz covariance are developed. Treatment of interacting fields by use of the Lagrangian formulation is illustrated by the consideration of charged particles in an electromagnetic field. Noether's theorem and its connection with conservation laws are outlined, and the application to the particular case of orthochronous Lorentz transformations is described. Following a review of gravitational experiments supporting the general theory of relativity, the concepts of gravitational and inertial mass equivalence, general covariance, the metric tensor, Riemannian space, and covariant differentiation are developed. The Bianchi identities are derived from the symmetry properties of the affine connection in the Riemannian metric space. Subsequently, gravitational field equations for gravitational fields only and in the presence of other fields are derived. The necessity for explicitly introducing an interaction term in the conventional and quantum mechanical theory is contrasted with the automatic, implicit interaction found in the gravitational field theory. Exact solutions are obtained for the spherically-symmetric Schwarzschild case. The approximate theory for the weak field case is discussed. (auth)

5663 TOPICS IN FIELDS AND SOLIDS. Coulter, C. Alton; Shatas, Romas A. (eds.). New York, Gordon and Breach, Science Publishers, 1968. 226p. $9.75.

Separate abstracts were prepared for the four topics discussed. (W.H.K.)

For abstracts of individual lectures see: 5457, 5662, 5670, and 5671.

Quantum Field Theory

Refer also to abstracts 5512 and 5597.

5664 (DESY-68/46) CONSISTENCY PROBLEMS IN VECTOR MESON DOMINANCE MODELS. Zimmermann, Wolfhart (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Aug. 1968. 6p. Dep.

Consistency problems are discussed for models where the electromagnetic field and a neutral vector meson field are coupled to the same current. It is shown that the conventional formulation of this model is inconsistent if the bare meson mass is infinite. However, no contradiction could be found for a different formulation of the model which is due to Kroll, Lee and Zumino. Finally a simple proof is given that the wave function renormalization constant of the electromagnetic field is finite in this model. (auth)

5665 POLARIZATION OPERATOR OF QUANTIZED FIELDS. Rumer, Yu. B.; Fet, A. I. (Novosibirsk State Univ., USSR). Zh. Eksp. Teor. Fiz., 55: 1390-2(1968). (In Russian).

A field description is proposed which involves the representations of the extended Poincare group which depends on 11 parameters and includes besides the Lorentz and shear transformations, the "duality rotation" operation introduced by Misner and Wheeler. (auth)

5666 ISOSPIN AND LOCAL SPACE–TIME ROTATIONS. Valatin, J. G. (Queen Mary Coll., London). Commun. Math. Phys., 10: 179-98(Oct. 10, 1968).

An 8-component spinor field carries with itself a large number of 4-vector currents and invariants, the relationships between which are analyzed. The vector densities can be grouped into a number of orthogonal frames, which describe tetrad fields. Two of the tetrads, related to each other by charge conjugation, con-

nect isospin transformations directly with local space-time rotations. The main tetrad planes determine geometrical configurations of considerable symmetry. The bilinear invariants define angles and hyperbolic angles which appear directly in the rotations and Lorentz transformations connecting the tetrads. (auth)

5667 A RIGOROUS FORMULATION OF LSZ FIELD THEORY. Steinmann, O. (Univ., Goettingen, Ger.). Commun. Math. Phys., 10: 245-68(Oct. 10, 1968).

An exact formulation of LSZ field theory is given. It is based on the Wightman axioms, asymptotic completeness, and a technical assumption stating the existence of retarded products of field operators. Reduction formulas are derived directly from the strong asymptotic condition. The GLZ-theorem, which states the conditions under which a given set of retarded functions defines a field theory, is formulated and proved in a rigorous way. (auth)

5668 PERTURBATION THEORY OF MASSIVE YANG–MILLS FIELDS. Veltman, M. (Univ. of Utrecht. Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys., B7: 637-50(1968).

Perturbation theory of massive Yang-Mills fields is investigated with the help of the Bell-Treiman transformation. Primitive diagrams containing one closed loop are shown to be convergent if there are more than four external vector boson lines. The investigation presented does not exclude the possibility that the theory is renormalizable. (auth)

5669 COVARIANT THEORIES OF ANTISYMMETRIC MASSIVE TENSOR OF RANK TWO. Cukierda, T.; Lukierski, J. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 16: 657-62(1968).

The most general formulation of the free massive vector field theory is discussed by means of the antisymmetric tensor field $G_{\mu\nu}$. It was shown that in the whole one-parameter family of theories, only the one proposed by Weinberg has the satisfactory Lagrangian formulation. Because the Weinberg's theory is equivalent to the conventional formulation, it can be concluded that the representation (1,0) + (0,1) does not open any new promising possibilities, which could be exploited for example in the discussion of the renormalizability problem of vector meson theories. (auth)

5670 INTRODUCTION TO NONRELATIVISTIC QUANTUM FIELDS AND DIAGRAM TECHNIQUES. Coulter, C. Alton; Morris, B. M. (Army Missile Command, Redstone Arsenal, Ala.). pp 1-95 of Topics in Fields and Solids. Coulter, C. Alton; Shatas, Romas A. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

Graduate-level lectures given at the 1964 summer seminar in theoretical physics at Redstone Arsenal are presented. The fundamentals of nonrelativistic quantum field theory are discussed. The discussion begins with a review of the Heisenberg and Schrödinger pictures in ordinary quantum mechanics, and then proceeds immediately to a development of the second-quantization formalism. Operator fields with appropriate boson and fermion equal-time commutation relations are introduced, and the details of the mathematical representation and physical interpretation are worked out for the case of noninteracting particles. The theory is then extended to embrace two-body particle-conserving interactions, and finally particle-nonconserving interactions are treated. The method for obtaining alternative forms of the theory by expanding the field operators in terms of complete orthonormal sets of functions is discussed. The integral equation of motion in the interaction picture is developed, and its solution is obtained by successive approximations. The Dyson chronological operator is defined. Examples of time-independent and time-dependent perturbation theory in the interaction picture are given. Ordinary and chronological contractions of operator products are defined, and the use of Wick's theorem in an evaluation of the perturbation expansion for the ground state energy of a system of interacting fermions is described. The representation of the perturbation expansion by Goldstone diagrams is explained. (auth)

5671 QUANTUM FIELD THEORY OF LATTICE VIBRATIONS IN THE HARMONIC APPROXIMATION. Shatas, Romas A.; Coulter, C. Alton; Stettler, John D.; Howgate, David W. (Army Missile Command, Redstone Arsenal, Ala.). pp 185-213 of Topics in Fields and Solids. Coulter, C. Alton; Shatas, Romas A. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

The concept of the quasiparticle of the free lattice vibrational field in the formalism of quantum field theory is developed. First the procedure of first-quantization of the lattice in the harmonic approximation is reviewed. The classical Hamiltonian of a lattice is describable by a sum of Hamiltonians, each characterizing a member of a set of harmonic oscillators. Any oscillator of this set can be first-quantized by the procedure $H \sim \frac{1}{2}(p^2 + q^2) \rightarrow \hbar(cc^+ + c^+c)$, $[c_i, c_j^+]_- = \delta_{ij}$. This leads to the occupation number representation $H \sim \hbar(N + \frac{1}{2})$, with N, the number operator, given by the bilinear form $c^+c = N$. Here $c^+ \sim (p + iq)$ and its adjoint, c, are raising and lowering operators of the energy eigenstates of one vibrational mode. The c's, although they obey the same commutation relations as creation and annihilation operators, are only first-quantized. However, in a second-quantized theory proper, a creation operator operating on the vacuum state creates a one-particle state. Consequently, a second-quantization procedure is employed in which the wave functions of the first quantized harmonic oscillator problem in the coordinate representation are replaced by field operators ψ^+, ψ. Their expansion in an orthonormal set of functions satisfying the differential equation of the harmonic oscillator in the coordinate representation yields a set of operator expansion coefficients b_n^+, b_n which are the creation and annihilation operators of the second-quantized formalism. The consistency of the results is shown by demonstrating the equivalence of the first- and second-quantized lattice Hamiltonians. (auth)

5672 FUNCTIONAL INTEGRALS IN QUANTUM FIELD THEORY AND RELATED TOPICS. Tarski, Jan (Columbia Univ., New York). pp 433-529 of Quantum Theory and Statistical Physics. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

A comprehensive discussion is given of some functional methods in physics. Two functional integrals are emphasized, the Wiener integral and the commutative Hilbert space integral. Functional derivatives and other examples of functional integrals are also included. Applications are given to quantum field theory. (L.B.S.)

5673 QUANTIZATION OF HIGHER SPIN FIELDS. Takahashi, Y. (Dublin Inst. for Advanced Studies). pp 351-431 of Quantum Theory and Statistical Physics. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

An attempt is made to evolve a unified approach for quantizing fields of arbitrary spin. First, the classical field theory for relativistic free fields is studied from a unified point of view. The wave equations for the various spin fields are reviewed. Common properties of the various fields are discussed next. The "first identity" is introduced which is essentially the configuration space version of the generalized Ward identity. Conservation laws are studied making use of the first identity but without reference to any explicit Lagrangian. The Klein–Gordon divisor and the second identity are introduced and discussed. A discussion of how to construct the Klein–Gordon divisor is also given. A unified treatment of the normalization and closure conditions for the c-number solutions of the general wave equation is presented. Quantization is carried out using the method described. In this connection the raising and lowering operators are introduced and the connection between spin and stastistics is also briefly discussed. Simple examples are given and the uniqueness of P_μ and $M_{\mu\nu}$ is proved. (L.B.S.)

5674 THIRRING MODEL. Klaiber, Bernhard (Princeton Univ., N. J.). pp 141-76 of Quantum Theory and Statistical Physics. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

An operator solution is given of the Thirring model in a well-defined Hilbert space. The introduction of an indefinite metric space for the description of the massless scalar field is avoided. The positive definiteness condition is then automatically fulfilled. A two-parameter family of solutions is obtained in which the solutions of Johnson and Schwinger are contained as a subfamily. The properties of the solutions are extensively discussed. (L.B.S.)

5675 LOCAL TENSOR FIELDS AND THE ENERGY–MOMENTUM OPERATOR. Orzalesi, C. A.; Sucher, J.; Woo, C. H. (Univ. of Maryland, College Park). Phys. Rev. Lett., 21: 1550-3(Nov. 25, 1968).

It is shown that for any local tensor field $f_{\mu\nu}(x)$ with certain natural properties, the space integral of $f_{0\nu}$ is proportional to the energy-momentum operator P_ν. General conditions are established under which the agreement of a charge operator with the space integral of a local density on the one-particle subspaces implies their agreement on all of Hilbert space. (auth)

5676 FEYNMAN RULES FOR ELECTROMAGNETIC AND YANG–MILLS FIELDS FROM THE GAUGE-INDEPENDENT FIELD-THEORETIC FORMALISM. Mandelstam, Stanley (Univ. of California, Berkeley). Phys. Rev., 175: 1580-1603(Nov. 25, 1968).

The Feynman rules for the Yang–Mills field, originally derived by Feynman and DeWitt from S-matrix theory and the tree theorem, are here derived as a consequence of field theory. The start-

ing point is the gauge-independent, path-dependent formalism which was proposed earlier. The path-dependent Green's functions in this theory are expressed in terms of auxiliary, path-independent Green's functions in such a way that the path-dependence equation is automatically satisfied. The formula relating the path-dependent to the auxiliary Green's functions is similar to the classical formula relating the path-dependent field variables to the potentials. By using a notation similar but not identical to Schwinger's functional notation, the infinite set of equations satisfied by the Green's function can be replaced by a single equation. When the equation for the auxiliary Green's functions of electromagnetism is solved in a perturbation series, the usual Feynman rules result. For the Yang–Mills field, however, one obtains extra terms; such terms correspond precisely to the closed loops of fictitious scalar particles introduced by Feynman, DeWitt, and Faddeev and Popov. (auth)

5677 COHERENT SOFT-PHOTON STATES AND INFRARED DIVERGENCES. IV. THE SCATTERING OPERATOR. Kibble, T. W. B. (Univ. of Rochester, N. Y.). Phys. Rev., 175: 1624-40(Nov. 25, 1968).

In Paper III of this series, the asymptotic states of quantum electrodynamics were defined in terms of the mass-shell singularity structure of the Green's functions. In this paper the reduction formulas obtained are used to derive simple expressions for the matrix elements of the scattering operator. This operator is defined on the space of asymptotic states, which is the direct product of the Fock space of the particles (massive particles and hard photons) with the nonseparable Hilbert space, defined in Paper I, which is spanned by the soft-photon coherent states. It is shown that the scattering operator so defined is gauge-invariant, Lorentz-invariant, unitary, crossing-symmetric, and independent of the choice of the small parameter that defines the separation between hard and soft photons. For a given initial state, the only nonvanishing scattering matrix elements are those to final states in a specific equivalence class, and conditions for states to be equivalent in this sense are obtained. The relationship between these matrix elements and physically measurable cross sections is discussed. In this way, results obtained by conventional methods are reproduced, but in addition questions inaccessible to such methods, such as the effect of an infinite number of soft photons in the initial state, may be investigated. (auth)

5678 ELECTRODYNAMICS WITH A QUANTUM OF LENGTH. Ford, Kenneth W. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 175: 2048-53(Nov. 25, 1968).

Generalized from the work of Yan, electrodynamics with a length quantum is developed at the level of classical mechanics and ordinary quantum mechanics. In this theory, the length quantum λ is a space-time distance over which operators and field variables are averaged. No space-time granularity or any other departure from special relativity is introduced. However, the free-particle wave equation may be expressed as a difference equation. For λ even as large as 10^{-13} cm, effects on low-energy electron phenomena (magnetic moment, Lamb shift, and fine structure) are negligible. For $\lambda \cong 5 \times 10^{-16}$ cm, a perceptible shift of the muon magnetic moment is predicted. Other consequences, especially at high energy, remain to be explored, as does the second-quantized version of the theory. (auth)

Gravitation and General Relativity

Refer also to abstracts 5496, 5566, and 5662.

5679 RELATIVISTIC THEORIES OF GRAVITATION. Kustaanheimo, P. E.; Nuotio, V. S. (Univ. of Helsinki). Nature (London), 220: 696-7(Nov. 16, 1968).

Reference is made to Whitrow and Morduch (Nature 188: 790 (1960)), who examined the Lorentz-invariant theories of gravitation and calculated most of the known empirical tests for these theories, with a view to examining the possibility of deciding experimentally between them and Einstein's general theory of relativity. The present authors have continued the work of Whitrow and Morduch by classifying all possible Lorentz-invariant theories of gravitation that satisfy certain general axioms and by analysing the one-body problem in these theories. The axioms are: (i) Lorentz invariance; (ii) Galilean principle of equivalence; (iii) principle of linear superposition; (iv) freedom from singularities; (v) principle of dimensionless universal constants; (vi) that gravitational interaction is propagated with the velocity of light; (vii) that the velocity of light is limiting velocity never attained by a mass point; (viii) that the first approximation for slow relative motions should coincide with Newton's theory. (UK)

5680 GENERAL COVARIANT QUANTIZATION OF GRAVITATION AND COSMOLOGY. Al'tshuler, B. L. Zh. Eksp. Teor. Fiz., 55: 1311-20(1968). (In Russian).

A method for general covariant quantization of gravitation is proposed which is similar to quantization of "ordinary" fields in an external field $g_{ik}(x)$. The metric of the Riemann quantization space is defined as the mean of the gravitation field Heisenberg operator with respect to the ground state of the system of interacting quantized fields and satisfies the Einstein equations. A natural definition of the covariant Green function of the gravitational field is given. The possibility of spontaneous violation of the general coordinate transformation group is analyzed by analogy with the corresponding quantum field theory models. It is demonstrated that this approach is equivalent to the condition that all particles are compound (that is, to the bootstrap condition). In this case a zero mass tensor particle (graviton) should exist which is the bound state of some other particles. The homogeneous Bethe–Salpeter equation for the vertex of a scalar meson (of mass m) and graviton is solved on the assumption that the interaction between mesons in the long wave region is purely gravitational. The graviton mass ρ (introduced for removal of infrared divergences) is expressed in terms of m and k (k is the gravitational constant) on basis of the condition of a correct classical limit for the meson-graviton vertex. For $m = m_p$ (m_p is the proton mass) this yields $1/\rho \approx 10^{27}$ cm which is approximately equal to the radius of curvature of the world in a real cosmology. (auth)

5681 EQUATION OF MOTION OF A VARIABLE MASS SOLID IN THE GENERAL THEORY OF RELATIVITY. Rozenberg, L. A. Prikl. Mat. Mekh., 32: 521-9(1968). (In Russian).

Co-variant equations obtained for motion of variable mass point (forward) in the general theory of relativity are used for describing the Schwarzschild field, in the external field of a spherically rotating symmetric mass in the Einstein universe. (R.V.J.)

5682 MODIFICATION OF EINSTEIN'S EQUATION OF MOTION OF A TEST PARTICLE IN A "WEAK GRAVITATIONAL FIELD." Ray, Dipankar (Presidency Coll., Calcutta). Indian J. Phys., 42: 140-1(Feb. 1968).

Einstein (1921) and more recently Davidson (1957) have investigated the equation of motion of a test particle under the weak field approximation. While Einstein obtained the equation (in his notation) $d/dl\ (1 + \sigma)\vec{v} = \vec{\nabla}\sigma + \partial\vec{A}/\partial t + (\vec{\nabla} \times \vec{A}) \times \vec{v}$. Davidson pointed out an inconsistency in Einstein's calculation and gave the equation $d/dl\ (1 + 3\sigma)\vec{v} = \vec{\nabla}\sigma + \partial\vec{A}/\partial l + (\vec{\nabla} \times \vec{A}) \times \vec{v}$. A careful reexamination of the approximation procedure has however led to the following equation $dv/dl = \vec{\nabla}\sigma + \partial\vec{A}/\partial t + (\vec{\nabla} \times \vec{A}) \times \vec{v} - 3\ \partial\sigma/\partial t\ \vec{v}$. (auth)

5683 ON THE CALCULATION OF MASS RELATION OF PROTON/ELECTRON. Stanyukovich, K. P. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 5, 3-7(Sept.-Oct. 1968). (In Russian).

Proton–electron mass relations in a gravitational field were calculated using Landau equations for quantum thermodynamics. (R.V.J.)

5684 EQUIVALENCE PRINCIPLE AND MOTION OF A GYROSCOPE. Parker, L. (Univ. of North Carolina, Chapel Hill). Phys. Rev., 175: 1658-60(Nov. 25, 1968).

An incorrect application of the equivalence principle to the motion of a gyroscope in a uniform gravitational field is corrected, and a particular formulation of the equivalence principle is discussed. In applying the principle of equivalence, the entire physical situation, including the observer's reference frame, should be subjected to an equivalent acceleration in the absence of the field, and not just the system under observation. It is shown how the equivalence principle and the Thomas precession can be used to obtain the precessional angular velocity of a moving gyroscope in a uniform gravitational field. The result is confirmed by means of general relativity. (auth)

5685 FEYNMAN RULES FOR THE GRAVITATIONAL FIELD FROM THE COORDINATE-INDEPENDENT FIELD-THEORETIC FORMALISM. Mandelstam, Stanley (Univ. of California, Berkeley). Phys. Rev., 175: 1604-23(Nov. 25, 1968).

By using the method developed, the Feynman–DeWitt perturbation expansion for the gravitational S matrix is shown to follow from the field-theoretic formalism. Again our method is to express the path-dependent Green's functions in terms of auxiliary, path-independent Green's functions, in such a way that the path-dependence equation is automatically satisfied. The formula relating the path-dependent to the path-independent Green's functions will be similar to the classical formula relating the path-dependent Riemann tensor to the metric tensor. The equations for the auxiliary Green's functions are found and solved in a perturbation

series. If the result is expressed as a sum of Feynman diagrams, one obtains the expected vertices, together with closed loops of fictitious vector particles. (auth)

5686 LUNAR LASER RANGING AND THE BRANS–DICKE THEORY. Krogh, Christine; Baierlein, Ralph (Wesleyan Univ., Middletown, Conn.). Phys. Rev., 175: 1576-9(Nov. 25, 1968).

Laser ranging to an optical corner reflector on the lunar surface may make possible a test of non-Newtonian gravitational theories. The results of a theoretical calculation of the Brans–Dicke corrections to the laser-pulse transit time are compared with results previously obtained for the Einstein theory. A further analysis of the measurable non-Newtonian correction term which dominates the predictions of both theories indicates that the term probably is common to all Lorentz-covariant gravitational theories. (auth)

Scattering Theory

Refer also to abstracts 5498, 5596, 5601, and 5974.

5687 (JINR-P2-4067) INVARIANT EXPANSIONS IN A CONE AND UNITARY TRANSFORMATIONS OF THE AMPLITUDES. Liberman, M. A.; Makarov, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 27p. (In Russian). Dep.

The functions are constructed which realize irreducible transformations of the Lorentz (at $\Delta' = 0$) and correspond to the different reductions of the Lorentz group. The functions obtained are used for invariant expansion of the scattering amplitude and for deduction of the ratio of the Pomeranchuk theorem type. The reexpansion coefficients of the functions of one complete set of the commuting operators in functions of the other set have been determined. (auth)

5688 (LPTHE-TH-68/18(Rev.)) RISING REGGE TRAJECTORIES AND CROSSING SYMMETRY. Caser, S.; Kaplan, J. M.; Omnes, R. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). July 1968. 13p. Dep.

If there are infinitely rising Regge trajectories, the asymptotic behavior of the Regge pole terms in the s and t channels cannot be compatible with each other in the whole s,t plane. Thus the background integral cannot be neglected asymptotically if crossing symmetry is to be valid. This is in contradiction with the bounds obtained by Khuri on the behavior of the background integral out of the physical region. It is shown in a mathematical example that these bounds cannot be extended outside the physical region. As a consequence of this, there does not remain any restriction neither on the rate of increase of possible rising Regge trajectories except possibly a lower bound in $\sqrt{s}$ nor in the behavior of the residue functions. (auth)

5689 (LPTHE-TH-68/29) ON THE RELATION BETWEEN CURRENTS AND S-MATRIX. Omnes, R. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Sept. 1968. 6p. Dep.

The problem of the determination of currents and the off-mass-shell extension of scattering amplitudes is considered within the context of analytic S-matrix theory, keeping up to three particles inside the unitarity relations. The technique which is used is a straightforward application of the work by Mandelstam on the N/D formulation of the three-body problem. It is found that anomalous thresholds do not play any role in the problem and that two cases can be solved explicitly, namely: the extension off the mass shell of the scattering amplitude and the computation of a form factor which tends to zero asymptotically. (auth)

5690 THE PROBLEM OF DIPS IN REGGE POLE AMPLITUDES. Oehme, R. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett., 28B: 122-4(Nov. 11, 1968).

Fixed poles at nonsense wrong-signature points do not necessarily imply singular Regge pole residua. Hence the simple dip mechanism is not disturbed by these poles. (auth)

5691 STRONG COUPLING IN THE POMERANCHUK POLE PROBLEM. Gribov, V. N.; Migdal, A. A. (Leningrad Inst. of Physics and Tech.). Zh. Eksp. Teor. Fiz., 55: 1498-1520(1968). (In Russian).

The possibility of strong coupling in the Pomeranchuk pole problem is investigated corresponding to the circumstance that under the influence of branching points the trajectory and pole residues considerably change. It is demonstrated that due to the non-Hermitian nature of the reggion interaction this possibility is not self-consistent; thus the coupling should be weak, that is, the reggion constants should vanish after renormalization The structure, analytic properties and asymptotic behavior of the reggion Green functions were found for Hermitian interaction. Hermitian problems of strong coupling are encountered in the physics of condensed media for which the scattering amplitudes (Green functions) have closely spaced singularities at low momenta and the perturbation theory expansion parameter tends to infinity (phase transitions etc.). The present analysis may be useful in these problems. (auth)

5692 RELATIVISTIC REGGE APPROACH FROM THE BETHE–SALPETER EQUATION. Seto, Kenji (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto), 40: 605-19 (Sept. 1968).

The Bethe–Salpeter equation of the Wick-Cutkosky model for the scattering amplitude is investigated by means of the stereographic projection method, which leads us to the O(4) invariant transformation property of the equation in all energy regions. This transformation property enables the scattering amplitude to be decomposed into the partial wave amplitude with the four-dimensional angular momentum quantum number L. By the analysis of the scattering amplitude in the form of the Khuri representation in the complex L plane, it can be shown that the series of the parent trajectories themselves constitute the cancellation mechanism of the Khuri satellite poles at $s = (m_1 - m_2)^2$ in the same manner as Freedman and Wang obtained the series of daughter trajectories. (auth)

5693 NORMALIZATION OF THE DEGENERATE B–S AMPLITUDES. Arafune, Jiro (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 40: 620-7(Sept. 1968).

A general method of the normalization of the degenerate multiple-pole B-S amplitudes is shown. An application to the Wick-Cutkosky model at $P^2 = 0$, $P \neq 0$ is given as an example. (auth)

5694 S-MATRIX AND ABNORMAL SOLUTIONS OF THE BETHE–SALPETER EQUATION. Naito, Seiichi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 40: 628-39(Sept. 1968).

The S-matrix for two spinless particles interacting through a massive scalar field is considered in the ladder approximation. Residues of poles in the S-matrix are expressed in terms of normalized Bethe-Salpeter amplitudes on the mass shell. In particular, residues are evaluated for zero energy-momentum states and some of them are rigorously shown to be non-zero. Furthermore, it is proved in the equal-mass case that residues for massive bound states can be obtained from those for zero energy-momentum bound states, by means of a series expansion in powers of the bound state mass. In other words, any "massive state" of even p_0-parity is observable as a pole of the S-matrix, when the corresponding "zero energy-momentum state" has a non-vanishing residue. (auth)

5695 ORBITING AND RESONANCE STATES. Lukach, I.; Smorodinskii, Ya. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 55: 1296-1303(1968). (In Russian).

A quantum mechanical investigation of the behavior of elastic potential scattering is carried out for energies of the order of the effective potential barrier. In classical scattering theory this phenomenon is known as orbiting (spiral scattering). It is found that for incident particle energies equal to the height of the effective potential barrier, a resonance appears in the scattering cross section which corresponds to the quasistationary state. The height of the effective potential barrier is a function of momentum of the incident particles and thus a resonance trajectory is obtained which defines a family of resonance energies for various momenta. (auth)

5696 LOOPS IN PARTIAL WAVE EXPANSION OF ASYMPTOTIC AMPLITUDES. Chiu, C. B.; Kotanski, A. (CERN, Geneva). Nucl. Phys., B7: 615-24(1968).

It is observed that the loops discovered recently on the Argand diagrams for the partial waves of a Regge pole represent a general property of an asymptotic amplitude. They are a direct consequence of the phase factor $\exp(-i\pi\alpha)$, which follows from the crossing symmetry and the asymptotic power behaviour $s^{\alpha}(\log s)^{\beta}(\log \log s)^{\gamma} \ldots$ for t fixed near the forward direction. Since the loops are closely connected to the phase factor, they can appear even at the low-energy region where the Regge amplitude gives a poor representation of the data. In this region it is conceivable that some of the physical partial waves can resemble the Regge partial waves, but it is difficult to give much significance to this similarity. A selection rule associated with the Regge loops in πN states is also noted. (auth)

5697 FACTORISATION, KINEMATIC FACTORS OF THE REGGE RESIDUE FUNCTION AND CONSPIRACY. Frampton, P. H. (Dept. of Theoretical Physics, Oxford). Nucl. Phys., B7: 507-26(1968).

When helicity amplitudes are Reggeized, the kinematic singularities and zeros of the helicity amplitudes are not generally compatible with the factorization theorem for the Regge residue function. The simplest (but not unique) class of solutions for the extra zeros which must be added to give factorization is found. The residue function for a t-channel helicity amplitude may be written $\beta_{\lambda\mu}(t) = \bar{\beta}_{\lambda\mu}(t)\, W_{\lambda\mu}(t)$, where $W_{\lambda\mu}(t)$ is a kinematic function. To satisfy the factorization theorem we must be able to write $W_{\lambda\mu}(t) = V_\lambda(t) V_\mu(t)$. The main result is that near $t = 0$ the vertex function $V_\lambda(t)$ is proportional to $t\hat{q}$ where, for unequal masses, $\hat{q} = -\frac{1}{2}\alpha + \frac{1}{2}|M - |\lambda||$ and, for equal masses (each with spin s), $\hat{q} = \frac{1}{4}[1 - (-1)^{\lambda+M}]$ is $M \geq 2s$ and $\hat{q} = \frac{1}{4}[1 - (-1)^{\lambda+2s}] + \frac{1}{2}(M - 2s)$ if $M \leq 2s$, where M is a non-negative parameter (integer for boson trajectories, half-integer for fermion trajectories), identified with a quantum number characterizing the Toller pole from which the Regge pole at complex angular momentum α arises. The general results for $V_\lambda(t)$ at thresholds and pseudothresholds, as well as at $t = 0$, are given. As a subsidiary result we show that the analytic structure of helicity amplitudes at thresholds, and at pseudothresholds for unequal masses, follow from non-relativistic arguments without study of the Trueman and Wick crossing relations. The results are applied, as an example, to the pion conspiracy problem, and some earlier results of Le Bellac are rederived. (auth)

5698 MATHEMATICAL THEORY OF MULTI-PARTICLE QUANTUM SYSTEMS. Hunziker, W. (Technische Hochschule, Zurich). pp 1-48 of Quantum Theory and Statistical Physics. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

The topics discussed include the construction of Hamiltonians; cluster properties; time-dependent scattering theory; cluster properties of the S-matrix, cross sections; and time-independent scattering theory. (L.B.S.)

5699 RELATIVISTIC PROTON–PROTON SCATTERING. Schierholz, G. (Univ., Hamburg). Nucl. Phys., B7: 483-97 (1968).

Elastic p-p scattering in the low-energy range is studied. Relativistic off-shell integral equations for the T-matrix are derived from relativistic scattering theory and a technique for obtaining solutions is discussed explicitly. A field theoretic potential is constructed within the framework of one-boson-exchange model. The numerical calculations are based on the exchange of π, η, ρ, and ω mesons. In addition two scalar mesons σ and s are assumed to parameterize the $\pi\pi$ S-wave contribution. The coupling constant of the σ meson is determined by low-energy $\pi\pi$ S-wave interaction. The off-shell integral equations for the T-matrix are solved numerically, and the predictions of the one-boson-exchange model are compared with empirical phase shifts. This leads to a set of well-founded coupling constants, which differ definitely from those of all recent investigations of nucleon-nucleon scattering, due to the consistent inclusion of unitarity and off-shell contributions. (auth)

5700 ANALYTICAL PROPERTIES OF THE SCATTERING AMPLITUDE AND REGGE POLE FAMILIES. Szego, Karoly; Toth, Kalman (Central Research Inst. for Physics, Budapest). Magy. Fiz. Foly., 16: 371-85(1968). (In Hungarian).

It has been shown earlier that Regge poles may be classified on the basis of four-dimensional rotational groups. In view to obtain information about the bound states of the scattering amplitude, the poles were studied because from the mathematical viewpoint the bound states appear as poles of the scattering amplitude. It was found sufficient to restrict the study to the scalar theory, considering the elastic scattering of scalar particles with masses of M and m, whereby a scalar particle with a mass of μ transmits the interaction. Derivation of the scattering amplitude, starting with the Bethe–Salpeter equation in its operator form, yielded a determinant which is suitable to be used for classification. The Regge poles could be classified according to the Lorentz group representations. In order to correlate the analytical property of the scattering amplitude with the Lorentz invariance, the partial wave amplitudes must be employed as the basis of the SL(2,C) representation. (TTT)

5701 RIGOROUS RESULTS IN SCATTERING THEORY. Marchand, Jean-Paul (Univ. of Geneva). pp 49-90 of Quantum Theory and Statistical Physics. Barut, Asim O.; Brittin, Wesley E. (eds.). New York, Gordon and Breach, Science Publishers, 1968.

The energy dependence of scattering is discussed in Jauch's axiomatic frame of simple scattering theory by means of the simplest soluble mathematical models. (auth)

5702 ANALYTIC CONTINUATION OF THE KHURI AMPLITUDES WHEN u = 0 AND ITS CONNECTION TO REGGE DAUGHTERS. Spector, R. M. (Wayne State Univ., Detroit). Nuovo Cim., 58A: 114-24(Nov. 1, 1968).

Freedman and Wang originally proved the existence of Regge daughter poles by a method involving the Khuri amplitudes. They analytically continued these amplitudes into complex regions and performed a Sommerfeld-Watson transformation. Unfortunately they had to assume the necessary analyticity properties when u = 0. It is shown how the required Khuri-amplitude behavior can be rigorously proven. This is done by interchanging the order of integration in the contribution of the Regge background discontinuity to the defining Khuri integrals. A simple expression for the Khuri amplitudes is found which is valid for u = 0 or complex. (auth)

5703 FIXED CUTS IN THE l-PLANE AND DIFFRACTION SCATTERING. Bassetto, A. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim., 58A: 308-12(Nov. 1, 1968).

A mechanism is proposed in which a fixed cut at $l' = 1$ in the crossed-channel partial-wave amplitude gives rise to singular forces that are able to reproduce, via the unitarity relation, the same singularity in the direct-channel amplitude. It is expected that a consistent picture should emerge where the inelastic contributions are important both as an absorption effect in the direct channel and as a singular potential effect when they are present in the crossed one. The "most singular integral equation describing the partial-wave amplitude in the elastic N/D approximation is solved, considering the $\pi^0 - \pi^0$ even-signature partial-wave amplitude. (L.B.S.)

5704 MODIFIED WKB APPROXIMATION FOR THE BOUND-STATE PROBLEM. Lu, P. (Arizona State Univ., Tempe). Nuovo Cim., 58A: 361-2(Nov. 1, 1968).

The work of Rosen and Yennie (Journ. Math Physics., 5: 1505 (1964)) is extended to the bound state problem by using a modified WKB approximation. (L.B.S.)

5705 ASYMPTOTIC BEHAVIOR OF THE NUMBER OF BOUND STATES OF A GIVEN POTENTIAL IN THE LIMIT OF LARGE COUPLING. Chadan, K. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim., 58A: 191-204(Nov. 1, 1968).

Given a potential V(r), which is assumed to be everywhere positive, nonincreasing as r increases, and for which $\int_0^\infty \sqrt{V(r)}dr < \infty$, it is shown that the number of bound states of $gV(r)$ in any angular, momentum state l has the asymptotic behavior $n_l(g) \sim \pi^{-1}\int_0^\infty \sqrt{V(r)}\, dr\sqrt{-g}$ in the limit $g \to -\infty$. On the basis of several examples, it seems that the above theorem is valid even if V(r) is only positive, without being everywhere nonincreasing. (auth)

5706 JOST-SOLUTION PHASE-SHIFT TO APPROACH POTENTIAL SCATTERING. Lopez, C. A. (Univ. de Chile, Santiago). Nuovo Cim., 58A: 160-70(Nov. 1, 1968).

The behavior near the origin of the irregular or Jost solution $f(\lambda, -k, r)$ of the radial Schrödinger equation for Yukawa-like potentials is considered. When both the total and centrifugal energies are negative it resembles the asymptotic behavior of the regular solution $\varphi(\lambda,k,r)$ for positive values of these variables. A new description of the scattering process is thus obtained by means of the irregular-solution phase shift at the origin $\omega(\lambda,k)$. This method is complementary to the usual approach which starts from the regular-solution phase shift at infinity $\delta(\lambda,k)$. The analytic properties of $\omega(\lambda,k)$ in λ are shown to be very similar to the corresponding properties in k of $\delta(\lambda,k)$, as a result of the symmetry between the Jost functions in both planes. Levinson's theorem in the λ-plane is then established, relating the number of Regge poles with the value of $\omega(\lambda,k)$ at the origin. Finally, dispersion relations satisfied by the function $\Lambda(\lambda,k) = \exp[2i\omega(\lambda,k)]$ are derived, using the completeness of the set of Jost solutions. (auth)

5707 LORENTZ EXPANSION FOR SCATTERING AMPLITUDES. Durand III, Loyal; Fishbane, Paul M.; Simmons, L. M. Jr. (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 21: 1654-8(Dec. 9, 1968).

An expansion of the spinless scattering amplitude A(s,t,u) in terms of the representation coefficients of the Lorentz group is discussed. The expansion preserves the cut structure of A(s,t,u) on a term-by-term basis, and is valid for arbitrary values of s,t,u. The expansion parameters are given in terms of Regge trajectory and residue functions. (auth)

5708 VENEZIANO FORMULA WITH TRAJECTORIES SPACED BY TWO UNITS. Mandelstam, Stanley (Univ. of California, Berkeley). Phys. Rev. Lett., 21: 1724-8(Dec. 16, 1968).

By representing a scattering amplitude as a sum of terms of the Veneziano type, one can cancel alternate trajectories and remain with trajectories spaced by two units of angular momentum.

This result is obtained without imposing a supplementary condition and without introducing poles in the Regge residues at nonsense wrong-signature integers. (auth)

5709 DAUGHTERS, CONSPIRACIES, AND LORENTZ SYMMETRY. Bitar, Khalil M.; Tindle, Graham L. (Univ. of California, Berkeley). Phys. Rev., 175: 1835-51(Nov. 25, 1968).

The Freedman–Wang prescription for the introduction of daughter trajectories is generalized to the arbitrary-spin case. The daughter problem is then investigated, within the framework of Lorentz symmetry, and a Regge-type representation for the asymptotic S matrix is obtained which satisfies all kinematic constraints. The representation is found to be equivalent to a Lorentz pole expansion in the case of elastic scattering. Some properties of the representations of the covering groups of the homogeneous Lorentz group and rotation group are also investigated. (auth)

5710 FACTORIZATION AND CONSTRAINTS IN REGGE-POLE THEORY. Capella, A.; Contogouris, A. P.; Tran Thanh Van, J. (Univ. de Paris, Orsay, France). Phys. Rev., 175: 1892-4(Nov. 25, 1968).

The behavior near zero momentum transfer of the Regge residues for a two-particle reaction is determined by means of analyticity and factorization. It is shown that, at least in all cases of present interest, the solution obtained satisfies the kinematical constraints provided that a classification and certain relations between the trajectories involved (identical to those obtained by group-theoretical methods) are imposed. (auth)

5711 EIGENVECTORS FOR THE PARTIAL-WAVE "CROSSING MATRICES". Balachandran, A. P.; Meggs, W. J.; Ramond, P. (Syracuse Univ., N. Y.). Phys. Rev., 175: 1974-7(Nov. 25, 1968).

Let a, b, c, d be spinless particles of equal mass, and consider the process $a + b \rightarrow c + d$. It was shown elsewhere that the crossing symmetry of the scattering amplitude for such a process implies an infinite number of finite-dimensional "crossing relations" for the associated partial waves. In this paper, explicit expressions are derived for complete orthogonal and biorthogonal sets of eigenvectors of the partial-wave crossing matrices. The general form of a partial wave which is consistent with crossing symmetry is thus determined. (auth)

5712 n-PARTICLE KINEMATICS AND A GENERALIZED PARTIAL-WAVE ANALYSIS. Klink, William H.; Smith II, Granville J. (Univ. of Iowa, Iowa City). Phys. Rev., 175: 2010-13 (Nov. 25, 1968).

A generalized partial-wave analysis is derived for n-particle reactions. (auth)

5713 FALSE POLES OF THE SCATTERING AMPLITUDE IN FIELD MODELS. Gostev, V. B.; Mineev, V. S. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 55: 1818-20(Nov. 1968). (In Russian).

On the basis of the well known expressions for the amplitudes of $V\theta$ scattering in the $V\theta$ sector of the Lee model or three-particle model, it is shown that for negative energies the amplitudes not only possess poles corresponding to discrete states, but also false poles. The properties of these poles and the difference between them and the false poles of potential scattering theory are investigated. A technique is proposed for ascertaining false poles in simple quantum-field models. (auth)

Particle Accelerators

Refer also to abstracts 5800 and 5912.

5714 (AERE-Trans-1098) TRANSFORMER-BASED HIGH-CURRENT ACCELERATOR. Abramyan, E. A.; Gaponov, V. A. Translated by C. R. Brightmore (Atomic Energy Research Establishment, Harwell, Eng.), from Preprint No. 19. 14p. Dep. CFSTI. UK 2s. 6d.

The working principle of a direct-current accelerator designed for accelerating electrons to energies of 1.5 MeV with a mean beam power of some tens of kilowatts and a power conversion efficiency of about 90% is described. The accelerator is essentially a transformer with a core consisting of insulated segments with a built-in acceleration tube; it works from a 50 Hz mains supply and is placed in a medium of compressed gas. In order to ensure constant electron energy the voltage on the tube is stabilized by regulating the current in the tube. The length of electron current pulses can be set from 0 to 5 ms, and the repetition rate at up to 50 per second. The mean current can attain $\frac{1}{6}$ of the maximum current per pulse. In order to develop up to 100 mA electron current through the tube in a beam of some mm diameter, magnetic lenses are fitted inside the tube. The shielding of air-gaps and other electrically stressed parts of the accelerator from radiation generated in the tube is ensured by screens of heavy metal, placed near the axis of the tube. A beam of 1.5 MeV energy and 25 kW mean power (I_{mean} approximately 17 mA) has been obtained. (auth)

5715 (AERE-Trans-1099) HIGH-CURRENT PULSED ELECTRON ACCELERATOR. Abramyan, E. A.; Vasserman, S. B. Translated by C. R. Brightmore (Atomic Energy Research Establishment, Harwell, Eng.), from Preprint No. 22. 11p. Dep. CFSTI. UK 2s. 6d.

The working of a direct-current pulsed accelerator with a Tesla transformer acting as the high-voltage source and the acceleration tube built into the transformer are described. The machine delivers electron currents of hundreds of amperes at energies of several Mev and pulse lengths in the range 10^{-3} to 10^{-5} second. The system permits operation both in single current pulses and at repetition rates of hundreds of cycles a second. An experimental machine (ELIT-1) is described, from which an electron current of 35 A was obtained with 1 MeV energy in pulse lengths of 2 μs and a repetition rate of 10 Hz. With these parameters the mean beam power was 0.7 kW. (auth)

5716 (BNL-12938) FUTURE OF HIGH-ENERGY ACCELERATORS. Blewett, John P. (Brookhaven National Lab., Upton, N. Y.). [1968]. 16p. (CONF-681017-5). Dep. CFSTI.

From 15th Nuclear Science Symposium, Montreal, Canada.

A review of high energy accelerators which are now in operation is presented. Accelerators under construction are discussed and very high energy machines, still far in the future, are listed and described. Possible uses of cryogenic and superconducting magnets are mentioned. Colliding beam projects in operation and planned are presented. (auth)

5717 (BNL-13020) BROOKHAVEN SUPERCONDUCTING DC BEAM MAGNETS. Britton, R. B. (Brookhaven National Lab., Upton, N. Y.). [1967]. 17p. Dep. CFSTI.

Development of superconducting beam magnets at Brookhaven is described. A radial field magnet winding with which one can develop multipole fields having two, four, six, eight, or more poles is described. The design of frames to contain the windings and the development of insulation for the superconductors are discussed. Also, the construction of superconducting ribbons of appropriate width, length, uniformity of thickness, strength, and stable current density is reported. (W.H.K.)

5718 (BNL-tr-237) CONTRIBUTION TO THE STUDY OF THE CLOSED ORBIT. Baconnier, Y. (European Organization for Nuclear Research, Geneva (Switzerland)). Translated for Brookhaven National Lab., Upton, N. Y., from report CERN-65-35. 62p. Dep. CFSTI.

The trajectories of particles in circular accelerators are studied in linear approximation. The unperturbed linear machine, the perturbed linear machine, means of observation and correction, and correction of the closed orbit are discussed. (W.H.K.)

5719 (CEAL-1044) SEMI-ANNUAL REPORT, JANUARY 1–JUNE 30, 1968. (Cambridge Electron Accelerator, Mass.). Oct. 25, 1968. Contract AT(30-1)-2076. 33p. Dep. CFSTI.

Development and operation of the 6-GeV Cambridge Electron Accelerator during the period from January 1 to June 30, 1968, are presented. The various guiding committees are listed, and the high-energy experiments in progress or in preparation are outlined. The progress made on Project Bypass is summarized, and the status of the on-line detector for the colliding beam experiment and the magnetic design are described. Radiation safety is also discussed, and major publications are listed. (W.H.K.)

5720 (CERN-68-35) INTENSITY DEPENDENT EFFECTS AND SPACE CHARGE LIMIT INVESTIGATIONS ON CERN LINEAR INJECTOR AND SYNCHROTRON. Lapostolle, P. M.; Taylor, C. S.; Tetu, P.; Thorndahl, L. (European Organization for Nuclear Research, Geneva (Switzerland)). Oct. 12, 1968. 72p. Dep.

Experimental work on space charge effects at CERN on the PS and its linac injector was started in 1967 in an attempt to confirm theoretical intensity limits. Various unexpected effects are described which require more accurate experimental investigation and perhaps more development of the various theoretical approaches at present under way to explain them. (auth)

5721 (DESY-68/51) ELECTRON LOSSES IN STORAGE RINGS DUE TO PHASE FLUCTUATIONS OF THE rf VOLTAGE. Piwinski, A. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sept. 1968. 19p. Dep.

In electron storage rings it is desirable to have a very small synchronous phase angle. The lower limit of the phase angle is given by the rf power and by phase fluctuations of the rf voltage. The influence of small statistical phase fluctuations of the rf

voltage is investigated. Using the Fokker–Planck equation and taking into account the nonlinearity of the synchrotron oscillation, an expression for the energy spread and the lifetime of the stored particles is obtained. (auth)

5722 (DESY–68/52) COLLIMATION TESTS ON A COHERENT PHOTON BEAM FROM A SILICON TARGET. Criegee, L.; Garrell, M.; Sadrozinski, H.; Timm, U.; Zimmermann, W. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sept. 1968. 9p. Dep.

The narrow coherent spikes produced in strongly collimated bremsstrahlung spectra from thin silicon crystals was studied. Dependence of the spectra on crystal thickness and collimation was confirmed. The quality of the spectra obtained from internal synchrotron targets is seen to be limited because of the primary divergence of the electron beam. (auth)

5723 (LA–3728) GEOLOGIC STUDIES AND MATERIAL PROPERTIES INVESTIGATIONS OF MESITA DE LOS ALAMOS. Keller, M. Dean (comp.) (Los Alamos Scientific Lab., N. Mex.). June 1968. Contract W-7405-eng-36. 49p. Dep. CFSTI.

Investigations were conducted to verify the competence of the foundation material for the Los Alamos Meson Physics Facility and to provide relevant quantitative data for use by the architect-engineers in their facility design work. These investigations included geologic history, seismic probability, physical characteristics of the near-surface rocks, ground vibration characteristics, and deformation characteristics. (auth)

5724 (NYO–1480–101) LONG-TERM STABILITY FOR PARTICLE ORBITS. Laslett, L. Jackson; McMillan, Edwin M.; Moser, Juergen (New York Univ., N. Y.). July 1, 1968. Contract AT(30-1)-1480. 61p. (CONF-680115-1). Dep. CFSTI.

From Conference on the Mathematical and Computational Aspects of Accelerator Design, New York.

Mathematical considerations for long term stability for particle orbits in an alternating-gradient focusing structure for motion with only one spatial degree of freedom are presented. (W.H.K.)

5725 (RPI–328–141(Rev.)) VACUUM SYSTEM FOR HIGH-RADIATION ENVIRONMENT AT THE RPI LINAC LABORATORY. Haken, J.; Lewis, J. F.; Krasse, R. J. (Rensselaer Polytechnic Inst., Troy, N. Y. RPI Linac Lab.). [1967]. Contract AT(30-3)-328. 11p. (CONF-681012-1). Dep. CFSTI.

From 15th National Vacuum Symposium, Pittsburgh, Pa.

Vacuum system components on the 100-MeV RPI electron linear accelerator must operate in radiation fields averaging 5×10^5 rad/sec. Experience gained since the start of operations eight years ago indicates the special problems of constructing, maintaining, and modifying systems for high radiation environments. (auth)

5726 COLLIMATION TESTS ON A COHERENT PHOTON BEAM FROM A SILICON TARGET. Criegee, L.; Garrell, M.; Sadrozinski, H.; Timm, U.; Zimmermann, W. (Deutsches Elektronen-Synchrotron, Hamburg). Phys. Lett., 28B: 140-2(Nov. 11, 1968).

The narrow coherent spikes produced in strongly collimated bremsstrahlung spectra from thin silicon crystals were examined. Dependence of the spectra on crystal thickness and collimation has been confirmed. The quality of the spectra obtained from internal synchrotron targets is seen to be limited because of the primary divergence of the electron beam. (auth)

5727 ELECTRON OPTICAL PROPERTIES OF QUADRUPOLE AND OCTUPOLE ELECTRON LENSES. III. THIRD ORDER ABERRATIONS. Kanaya, Koichi (Electrotechnical Lab., Tokyo); Okayama, Shigeo; Mishina, Hiroshi. Denki Shikensho Iho, 32: 665-79(1968).

The third order aberration equations for evaluating a multistage quadrupole and octupole lens system are derived using the eikonal method. (auth)

5728 CHARGED PARTICLES ACCELERATOR. Abramyan, E. A.; Vasserman, S. B.; Gaponov, V. A.; Krainov, G. S. (to Institut Yadernoi Fisiki Sibirskogo Otdelenia Akademii Nauk USSR). Canadian Patent 792,864. Aug. 20, 1968. Priority date July 24, 1965, Russia.

An installation is described for accelerating charged particles to energies of several MeV using an impact-excited transformer (Telsa coil). Charged particle currents up to several hundred Amperes at an energy of a few MeV and with a pulse duration of 10^{-8} to 10^{-9} seconds are possible. The direct-voltage charged particle accelerator consists of: a body, a Tesla coil with primary and secondary windings and a magnetic conductor housed in the body, an electrode permeable to variable magnetic flux for uniform distribution of high potential. An acceleration tube is disposed inside the Tesla coil secondary winding and furnished with an injector and a control grid mounted close to the injector. Additional details of the electrical coupling are also given. (F.S.A.)

5729 RADIATION FROM MOVING CHARGE TRAIN. Hirakawa, Hiromasa (Tokyo Univ.). Jap. J. Appl. Phys., 7: 1523-7 (Dec. 1968).

The radiation power received by an antenna aiming at a moving train of density-modulated charge is calculated. The fact that a certain amount of energy is received in this way should not mean that a moving charge radiates energy in free open space. This point is discussed in connection with the emission of Cherenkov radiation in uniform medium. (auth)

5730 CERN INTERSECTING STORAGE RINGS. Johnsen, K. Cern Cour., 8: 263-6(Nov. 1968).

A general summary on the purpose of the ISR and on the major technical features of the project is presented. Topics discussed are the colliding beams, the intersecting storage rings, special requirements, interaction regions, bubble chamber, and construction program. (B.G.D.)

5731 COMPONENT PARTS [OF ISR]. 1. MAGNET SYSTEM. Resegotti, L. Cern Cour., 8: 267-9(Nov. 1968).

The magnet system of the CERN Intersecting Storage Ring is discussed. The system comprises of conventional steel-core magnets which have C-shaped cores with excitation coils around the two poles and with all gaps widening on the side opposite to the yoke to give maximum access to the vacuum chamber for detection and suppression of leaks. The system will have the capability for correcting for orbit distortions so the proton beam can be centered in the vacuum chamber. Special magnetic lenses are provided to avoid coupling of radial and vertical oscillations. Two different sets of magnets are added to serve the special requirements of experimentation with colliding beams. (B.G.D.)

5732 COMPONENT PARTS [OF ISR]. 2. RADIO-FREQUENCY SYSTEM. Schnell, W. Cern Cour., 8: 270-1(Nov. 1968).

The design characteristics of the CERN Intersecting Storage Ring radiofrequency system are presented. (B.G.D.)

5733 COMPONENT PARTS [OF ISR]. 3. VACUUM SYSTEM. Fischer, E. Cern Cour., 8: 271-2(Nov. 1968).

The vacuum system of the CERN Intersecting Storage Ring is briefly discussed. Topics include the vacuum chamber, pumping system, interaction regions, and beam transfer channels. (B.G.D.)

5734 COMPONENT PARTS [OF ISR]. 4. BEAM TRANSFER. de Raad, B. Cern Cour., 8: 273-5(Nov. 1968).

The requirements involved in transferring proton beams from the proton synchrotron to the Intersecting Storage Ring at CERN are discussed. Topics include beam transport, injection into the ISR, ejection from the ISR, and beam dumping. (B.G.D.)

5735 COMPONENT PARTS [OF ISR]. 5. POWER SUPPLIES. van der Meer, S. Cern Cour., 8: 275-6(Nov. 1968).

The power supplies for the two main magnet rings of the CERN Intersecting Storage Ring and the auxiliary power supplies to feed the correction magnets are briefly described. (B.G.D.)

5736 COMPONENT PARTS [OF ISR]. 6. GENERAL ENGINEERING. Horisberger, H. Cern Cour., 8: 276-7(Nov. 1968).

The General Engineering Group of the CERN Intersecting Storage Ring project, which provides mainly mechanical engineering services is described. The group consists of four sections: drawing office, mechanical workshop, cooling and air conditioning, and coordination and planning. (B.G.D.)

5737 COMPONENT PARTS [OF ISR]. 7. CONTROLS. Schaffer, G. Cern Cour., 8: 277-9(Nov. 1968).

The control problems associated with the CERN Intersecting Storage Ring are discussed. Topics include safety aspects, beam transfer channels, vacuum problems, and signal transmission and monitoring. (B.G.D.)

5738 COMPONENT PARTS [OF ISR]. 8. SITE WORK. Bonaudi, F. Cern Cour., 8: 279-83(Nov. 1968).

The site work for the CERN Intersecting Storage Ring is discussed. Topics include construction of the main ring, characteristics of the experimental wall, and contractors and suppliers. An ISR site layout diagram is included. (B.G.D.)

5739 COMPONENT PARTS [OF ISR]. 9. ALIGNMENT. Gervaise, J. Cern Cour., 8: 284-5(Nov. 1968).

The alignment techniques for some 1500 components of the 28-GeV proton synchrotron, transfer tunnels, and intersecting storage ring at CERN are discussed. Topics include civil engineering, design of measuring instruments, and metrology. (B.G.D.)

5740 PRECISE CONTROL OF LINEAR ELECTRON ACCELERATOR. I. RADIATION OF REQUIRED NUMBER OF PULSED

BEAMS. Yasuda, Kyoichiro (Government Industrial Research Inst., Nagoya, Japan); Kanaji, Toru Nagoya Kogyo Gijutsu Shikensho Hokoku, 17: 60-70(Mar.-Apr. 1968). (In Japanese).

A control method was studied to make a linear electron accelerator radiate accurately the required number of pulsed beams. Counting circuits were used to pre-set the number of pulses. All parts of the accelerator were kept in a fully warmed-up state, and the radiation was controlled by a magnetic shutter consisting of one pair of the solenoid coils placed between the electron gun and the acceleration tube. Shutter operation was automatically adjusted so that the transient state of the shutter does not overlap with the accelerator periodicity. The phase relation between the microwave pulse and the injected electron pulse was also controlled to diminish the effect of unexpected radiation due to the electron leakage through the shutter, so that they were not coincident with each other when the shutter was closed. The experiment showed that, the beam radiation was precisely controlled by this method, i.e., the quantity of the electrons included in each pulse was constant independent of the required number of the pulses, e.g., even if only a single pulse was radiated. There was no indication that beams radiated were not homogeneous. Leakage of radiation was not detected by an ion-chamber roentgenmeter. (NSA of Japan)

5741 ML-5 ELECTRON LINEAR ACCELERATOR FOR COMMISSARIAT A L'ENERGIE ATOMIQUE IN FRANCE. Irie, Koichi; Nemoto, Yoshiaki (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Lab. Rep., 42: 1392-8(Oct. 1968). (In Japanese).

A ML-5 electron linear accelerator delivered to the Commissariat a L'energie Atomique in France is a very powerful x-ray generator for its small size. The accelerator unit is less than 2 meters in total length, and microwave power supplied to it is above 5 MW at 2,856 MHz. With this apparatus an electron beam having an energy ranging from 2 to 7 MeV is available. Even at 3 MeV x-ray output of more than 1,000 R/min at 1 m can be obtained. The direction of x-ray radiation is changeable in the range of ±15° from a horizontal position. In addition, it has principal performances such that the maximum peak beam current is above 500 mA, the maximum average beam current above 800 μA, the energy spread below 10% and the minimum beam diameter about 3 mm. The construction of the device and technical problems are described. (NSA of Japan)

5742 INFLUENCE OF SPACE CHARGE ON PARAMETRIC RESONANCE OF BETATRON OSCILLATIONS IN ACCELERATORS. Kolomenskii, A. A.; Polukhin, A. T. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 5, 81-6(Sept.-Oct. 1968). (In Russian).

Formulas were obtained for determining the behavior of betatron oscillation amplitudes in the region of parametric resonance in the presence of space charge. It was shown that the influence of the charge on the resonance results in some cases in reduced and in other cases strongly increased oscillation amplitudes. The developed visual criteria are used to determine which of these two cases takes place in concrete accelerator parameters. (R.V.J.)

5743 FORMATION OF ELECTRON BEAM IN LINEAR ACCELERATOR WAVEGUIDE. Ostrovskii, E. K.; Makarov, A. F. Zh. Tekh. Fiz., 38: 1529-33(Sept. 1968). (In Russian).

Dynamics of particle beams ejected from a linear electron accelerator were studied. Data obtained on the transverse oscillations of electrons in the injector and in the first accelerator section enabled selection of the optimum focusing system and determination of the magnitude and divergence of the electron beam. It was shown that formation of a particle beam with a minimum divergence in the injection accelerator with β_2 = const demands relatively small fields with the intensity of 300 to 400 Oe. The magnitude of electron beam in the accelerator is determined by the particles distributed at the capture range boundaries. Reduction of the beam diameter and divergence at the injection point was achieved by using special shrinking-grouping devices. (R.V.J.)

5744 ACCELERATING FIELD OF LINEAR INDUCTION ACCELERATOR. Vakhrushin, Yu. P.; Semenov, O. V. Zh. Tekh. Fiz., 38: 1521-8(Sept. 1968). (In Russian).

Expressions were obtained for determining the magnitude of accelerating field at various points of the system. In addition to the induction acceleration field there are also potential fields produced by space charge and by potential of the inductor primary winding. Such fields do not influence the energy of the particle beam in accelerators but, by superimposing on accelerating field, they change its geometric configuration. The potential fields can be resolved by electrostatic methods. The studies were confined mainly to axial symmetric accelerating fields. (R.V.J.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 5442, 5454, 5828, 5858–5860, 5867, 5881, 5891–5893, 5900, 5916, 5925, 5968, 5969, 6001–6004, 6030, and 6031.

5745 (AE–334) COMPUTATION OF RESONANCE-SCREENED CROSS SECTION BY THE DORIX–SPENG SYSTEM. Haeggblom, H. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Sept. 1968. 33p. Dep.

A scheme is described for the computation of group cross sections for fast reactors in energy regions where the resonance structure of the cross sections may be dense. A combination of the programs Dorix and Speng is then used. Dorix calculates group cross sections for each resonance absorber separately. The interaction between resolved resonances in the same isotope is treated by a method described elsewhere. The interaction between correlated and non-correlated resonances in the unresolved region is also considered. By a Dorix calculation, effective microscopic cross sections are obtained which are then read in on a library tape. This library contains both point-by-point data group cross sections and is used in the Speng program for computation of spectrum and/or macroscopic cross sections. The resonance interaction between different isotopes is computed in Speng by the same method as was used in the Dorix program for non-correlated unresolved resonances. Consideration is also given to the width of the resonances compared to the energy loss by a neutron colliding with some of the scattering elements. (auth) (Sweden)

5746 (AEEW-M–790) WINFRITH NUCLEAR DATA GROUP NOTES ON TOPICS IN NUCLEAR DATA EVALUATION, 1964–8. James, M. F.; Story, J. S. (Atomic Energy Establishment, Winfrith (England)). May 1968. 63p. Dep. CFSTI. UK 9s. 0d.

A selection is given of brief notes written during the course of the past few years by the members of the Nuclear Data Group at the Atomic Energy Establishment, Winfrith. Many of the notes were tentative in nature and of ephemeral interest only, but those presented may have a wider interest to evaluators. (auth) (UK)

5747 (KURRI-TR–20) NEUTRON SPECTRA IN THE INTERMEDIATE ENERGY REGION. Inoue, Kazuhiko; Nanjo, Tsutomu; (and others) (Kyoto Univ. (Japan). Research Reactor Inst.). July 25, 1966. 7p. (In Japanese). Dep.

The neutron energy distribution in the intermediate region is largely changed by the ratio of absorption and moderation. To obtain a conceptual understanding of the neutron spectrum in the intermediate energy region, it is extremely useful to examine the general shape of a neutron spectrum, the positions of peaks, and the energy values where the absorption and fission occur the most, as against the relative magnitudes of absorption and moderation, and their correlations. For this purpose, two methods are proposed: one by the differential index, and the other by the integral index. In the first method, the problem is treated by means of the monotonously changing cross sections. But, since the absorption cross sections are of complex nature actually some suitable steps must be taken. In the second method, use is made of the exact resonance integrals. The three indexes, which express the characteristics of a neutron spectrum, are in the form of relatively simple functions; and they are connected to one another by a simple relationship. However, this is due to the use of the $1/v$ law for the absorption cross sections and the relation described can not in general be obtained for cross sections with complicated resonance absorption which actually occurs. (NSA of Japan)

5748 (KURRI-TR–36) THE INFLUENCE OF COLD NEUTRONS ON NEUTRON WAVE PROPAGATION EXPERIMENTS. Utsuro, Masahiko; Matsumoto, Takaaki; (and others) (Kyoto Univ. (Japan). Research Reactor Inst.). June 23, 1967. 39p. (In Japanese). Dep.

In the previous report, KURRI-TR-26, the results of experimental and theoretical investigations on the Bragg cut-off effects on neutron wave propagation in a particular case were given. Several additional experimental investigations and theoretical analyses were performed concerning this problem. First, the agreement between the two-group calculations and the experiments was improved by using recent information about the incident neutron energy spectrum. Secondly, an experiment proposed in the previous report was carried out. In the experiment, the incident neutron beam was directed tangentially to the propagating medium, permitting the cold neutrons to be treated separately by using the suitable filters and scatterers. (NSA of Japan)

5749 (KURRI-TR–40) REPORTS TO COMMITTEE ON REACTOR PHYSICS RESEARCH BY PULSED NEUTRONS IN FISCAL 1966 (KYOTO UNIVERSITY RESEARCH REACTOR INSTITUTE). (Kyoto Univ. (Japan). Research Reactor Inst.). 1967. 91p. (In Japanese and English). Dep.

The 14 reports presented at the meetings are given in the form of short articles dealing with the 20-m time-of-flight neutron analyzer at KURRI, the KURRI neutron generator and preliminary time-of-flight experiments, research program with the linear accelerator, differential neutron spectra by time-of-flight in JAERI, eigenvalues in neutron wave transmission, neutron measuring techniques, fast reactor neutron spectra, data analysis in neutron spectroscopy, pulse-shape discrimination in stilbene scintillator, thermal neutron scattering in moderators, pulse experiments in light water and natural uranium system, etc. (NSA of Japan)

5750 (KURRI-TR–45) ON THE ABSOLUTE MEASUREMENTS OF THERMAL NEUTRON FLUX. Nanjyo, Tsutomu (Kyoto Univ. (Japan). Research Reactor Inst.). [nd]. 18p. (In Japanese and English). Dep.

A method of measuring the absolute thermal neutron fluxes in slowing-down media is described. The concept of the thermal neutron spectrum and the definition of the thermal neutron flux are reviewed. The thermal neutron flux is defined by the Maxwellian component of the slow neutron flux. The slow neutron spectra and the associated indices were calculated for several borated light water media using Neikin's scattering kernel. In the present method, the unknown neutron spectrum is estimated by the comparison of the experimentally obtained cadmium ratio and the calculated ratio. The nuclear characteristics of gold are listed, and the problems of neutron absorption by probes, both bare and cadmium-covered, are treated. The $\beta-\gamma$ coincidence counting technique for ^{198}Au is mentioned. (auth)

5751 (RT/FIMA–(68)2) TWO-LEVEL RESONANCE FORMULAS AND THEIR APPLICATION TO THE CALCULATION OF THE EFFECTIVE RESONANCE INTEGRAL. Menapace, E.; Motta, M. (Comitato Nazionale per l'Energie Nucleare, Rome (Italy)). 1968. 33p. (In Italian). Dep.

A two-level formalism that takes into account resonance interference is outlined, and the computer program RESON which incorporates the formalism is briefly described. The program is written in FORTRAN for the IBM 7094. The results of sample calculations of the effective resonance integrals of ^{239}Pu and ^{233}U as functions of temperature are presented. (D.C.W.)

5752 (UCRL–50443) TRANSPORT-CORRECTED BOUNDARY CONDITIONS FOR NEUTRON DIFFUSION CALCULATIONS. Doyas, R. J.; McCormick, N. J. (California Univ., Livermore. Lawrence Radiation Lab.). June 7, 1968. 30p. Dep. CFSTI.

Numerical results, based upon one-speed transport theory, are tabulated for the boundary conditions to be used in a diffusion theory analysis of reactors and shields. Values are given for the ratios of densities and net currents at the interface between two media which are assumed to be thick as compared to their mean free paths. These results give the normalization factors required to make the diffusion quantities agree with the transport values at distances far from the interface. Values are also presented for the correct extrapolation lengths at which the density vanishes for the medium containing the source. The calculations take into account the effects of linearly anisotropic scattering in each of the two media and have been performed for 1,322 various combinations of material properties. The use of these numerical results to obtain the extrapolated end point approximation for the transport theory calculation of the critical thickness of a slab surrounded by two infinite reflectors is also discussed. (auth)

5753 SOME REMARKS ON GROUP CROSS SECTIONS FOR MIXTURES WITH A RESONANCE-SCATTERING COMPONENT. van Dam, H. (Reactor Instituut, Delft, Netherlands). Nukleonik, 11: 298-9(Oct. 1968).

The results are presented of a study concerning group cross sections for components of a mixture containing a resonance-scattering material. The effects of a scattering resonance on total cross sections and cross sections for elastic slowing down are considered. A comparison is given between data obtained from a group cross section code and values resulting from the Russian ABN-set; discrepancies up to a factor of 13 were found. (auth)

5754 MONTE CARLO PROGRAM FOR THE DETERMINATION OF THE ENERGY SPECTRUM OF PHOTONEUTRON SOURCES. Vesely, F.; Bensch, F.; Hejtmanek, H. (Oester-

reichische Hochschule, Vienna). Nukleonik, 11: 300-3(Oct. 1968).

The gamma and neutron transport in spherical photoneutron sources were simulated by a Monte Carlo routine. The results were: the relative neutron source strength per primary gamma quantum (comparable with experimental results); the energy spectrum of the emitted neutrons (no experimental results available); and the angular distribution of the emitted neutrons within each energy group (no experiments at present). (auth)

5755 REMARKS ON THE DEAD TIME-α (FIRST MOMENT) METHOD. Mikulski, A. T.; Szechter, A. (Inst. of Nuclear Research, Swierk, Poland). Nukleonik, 11: 303-5(Oct. 1968).

A method of determining prompt neutron decay constants is outlined in which the sequence of pulses from a neutron detector is passed through an artificial deadtime gate and the value of α is obtained from the relation between the number of input and output pulses. The results of a numerical experiment that was performed to verify the technique are presented. (D.C.W.)

5756 INTERFERENCE EFFECTS IN NEUTRON SCATTERING ON PROTONS IN A DOUBLE MINIMUM POTENTIAL. Schenk, C.; Weckermann, B. (EURATOM, Ispra, Italy). Phys. Lett., 27A: 582-3(Sept. 23, 1968).

Based on the theoretical treatments by Stiller and Stamenkovich of the incoherent neutron scattering at a proton in a double minimum potential well, experiments were performed with KH_2PO_4 single crystals to prove the predicted interference effect. (auth)

5757 DIFFUSION LENGTH AND CRITICALITY PROBLEMS IN TWO- AND THREE-DIMENSIONAL, ONE-SPEED NEUTRON TRANSPORT THEORY. I. RECTANGULAR COORDINATES. Williams, M. M. R. (London Univ.). J. Math. Phys. (N. Y.), 9: 1873-85(Nov. 1968).

Several problems in linear transport theory were solved involving more than one dimension. The diffusion-length problem in a slab system was considered and the variation of the flux in the transverse direction as a function of distance from the source was studied. The solution is found to consist of an asymptotic term, composed of a finite number of harmonics, plus a transient which is nonseparable in the x and z coordinates. When the slab is sufficiently thin only the transient term survives and the concept of a diffusion length loses its value. A method for overcoming this difficulty is presented. In another problem, the thickness of the slab is allowed to become semi-infinite, and the effect of decay in the z direction on the emergent angular distribution and surface flux are assessed. By approximating the flux in the y and z directions by a function of the form $\exp\{iB_y y + iB z\}$ and solving the resulting one-dimensional problem in the x direction exactly, it was possible to obtain a statement of the critical conditions in a bare rectangular parallelepiped system. The application of this method to the diffusion length problem in a system with a rectangular cross section is discussed. Finally, by comparison with the exact solution for the slab, the accuracy of a reduced Boltzmann equation deduced in a previous publication was estimated. (auth)

5758 DIFFUSION LENGTH AND CRITICALITY PROBLEMS IN TWO- AND THREE-DIMENSIONAL, ONE-SPEED NEUTRON TRANSPORT THEORY. II. CIRCULAR CYLINDRICAL COORDINATES. Williams, M. M. R. (London Univ.). J. Math. Phys. (N. Y.), 9: 1885-9(Nov. 1968).

An integral equation is derived which describes the diffusion of neutrons from a plane source perpendicular to the axis of an infinite circular cylinder. The equation is solved by a Fourier transform in the axial direction and by the subsequent solution of a singular integral equation for the radial distribution; this is accomplished as a result of a certain replication property possessed by the original integral equation. The Fourier transform is inverted to obtain the simultaneous $r - z$ variation of the neutron density in the cylinder. In addition, a formula is given from which the angular distribution of neutrons may be obtained. By approximating the density along the axis of the prism with the asymptotic distribution, it has been possible to assess the effect of axial leakage on the cylindrical critical problem. A critical equation is derived, and the appropriate extrapolated endpoints to be used in this are defined. (auth)

5759 ASYMPTOTIC BEHAVIOR OF CERTAIN NONLINEAR BOUNDARY-VALUE PROBLEMS. Canosa, Jose (IBM Scientific Center, Palo Alto, Calif.); Cole, Julian. J. Math. Phys. (N. Y.), 9: 1915-21(Nov. 1968).

The asymptotic properties of a class of nonlinear boundary-value problems are studied. For large values of a parameter, the differential equation is of the singular-perturbation type, and its solution is constructed by means of matched asymptotic expansions. In two special cases, very simple approximate analytic solutions are obtained, and their accuracy is illustrated by showing their good agreement with the exact numerical solution of the problem. (auth)

5760 USE OF INTEGRAL SPECTRUM MEASUREMENTS TO IMPROVE NEUTRON CROSS-SECTION DATA. Pendlebury, E. D. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 1177-82 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

The spectra of emergent neutrons from spherical shells of various materials with a central source of approximately fission spectrum neutrons have been measured at Harwell by M. S. Coates et al. A method which will allow these measurements to be used to improve neutron cross section data are described, and some of the outstanding theoretical problems associated with the application of the method are discussed. (auth)

5761 STUDIES OF THE ANGULAR DISTRIBUTION OF FAST NEUTRONS IN DEPLETED URANIUM. Greenspan, E.; Malaviya, B. K.; Kaushal, N. N.; Gaerttner, E. R.; Daitch, P. B. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. pp 1193-1201 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

Fast neutron time-of-flight measurements of position-dependent angular flux from a pulsed depleted uranium assembly were analyzed to obtain the energy-dependent angular and spatial neutron distributions and to study the relation between anisotropy in the neutron distribution and the differential elastic scattering cross section. The observed difference between different angular components of the flux indicates a strong anisotropy in the neutron distribution; this anisotropy is a strongly varying function of neutron energy and distance from the source in the assembly. A definite correlation is found between the anisotropy curve and the energy dependence of the differential elastic scattering cross section of ^{238}U. Preliminary transport theory calculations employing the 16-group Los Alamos cross-section set in an S_{16} approximation show that this cross-section set is inadequate to represent the anisotropic effects of neutron transport in ^{238}U. (auth)

5762 ADEQUACY OF FAST AND INTERMEDIATE CROSS-SECTION DATA FROM NEUTRON SPECTRUM MEASUREMENTS IN BULK MEDIA. Malaviya, B. K.; Greenspan, E.; Gaerttner, E. R.; Mallen, A. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. pp 1203-9 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

The measurement and analysis of intermediate and fast neutron spectra in bulk media provide a valuable means of checking cross-section data and recipes used for the generation of cross-section sets from point-wise data. As an illustration of this approach, position-dependent spectra from a 40-inch cube of iron were measured by the time-of-flight method, using the RPI LINAC and a set of calibrated detectors to cover the energy range of a few hundred eV to several MeV. The measured spectrum gives a fairly good representation of the resonance structure of iron. The experimental spectra are compared with calculations employing 49 energy groups from the ANL cross-section library and an S_{16} representation. Although the overall agreement is good, it is concluded that in order to better represent the fine structure in the spectrum it is necessary to go to a finer energy mesh and to define group boundaries so as to correctly describe the inter-group transfer cross sections. (auth)

5763 ON LINE COMPUTER SYSTEM FOR CROSS-SECTION EVALUATION. Beghian, L. E.; Tardelli, J. (Lowell Technological Inst., Mass.). pp 1117-21 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

In connection with a program for measuring fast neutron inelastic cross sections by the detection of the de-excitation gamma ray spectrum, using a time-gated Ge(Li) detector, the following data acquisition system is used. The output of the detector is fed

into a dual 4096-channel ADC interfaced to a PDP-9 computer on line, equipped with two tape transports. A program has been written to display visually the stored data, compute and subtract background from a peak of interest in the spectrum, and then locate the centroid of the peak. The program can be directed to construct a linear calibration curve from assigned calibration points using a least square fit method, and thus to assign an energy to the peak of interest. The program can be further extended to include spectrum stripping, and thus obtain the intensity as well as the energy of the peak. (auth)

5764 DATA REDUCTION WITH A SMALL REMOTE COMPUTER LINKED TO A CDC-6600. Moyer, W. R. (Rensselaer Polytechnic Inst., Troy, N. Y.); Bianchini, Ronald P.; Franceschini, Edi. Contract AT(30-3)-328. pp 1123-7 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

The neutron cross section measurements program at Rensselaer generates several millions of datum points per year. To process and analyze these data requires the services of a large and fast computer. This has been accomplished by linking, via voice grade telephone lines, an IBM-1130 computer at Rensselaer with the CDC-6600 computer at New York University (160 miles away). Communications software developed at the Division of Nuclear Engineering and Science has been tested and is in use exchanging card and printer image records with the CDC-6600 remote batch file at a speed of 2000 bits per second. Remote access to a large computer installation has greatly increased the efficiency of time-of-flight data processing through the reduction in turn-around time. (auth)

5765 CALCULATION OF PHOTON PRODUCTION CROSS SECTIONS AND SPECTRA FROM 4- TO 15-MeV NEUTRON INDUCED REACTIONS. Howerton, R. J. (Univ. of California, Livermore). pp 1013-20 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

Photon production cross sections and spectra resulting from the interaction of neutrons with nuclei are needed for shielding and other calculations. For 4- and ~15-MeV neutrons, as well as at some intermediate energies, cross sections and spectra were measured for some nuclei. From the 4- and ~15-MeV measurements semi-log plots of $N(E_\gamma)/E_\gamma$ vs E_γ show a generally linear dependence. The slope of these lines is linearly interpolable on nuclear mass and neutron energy. When the implied differential equation is integrated, an average energy ($\bar{E}$) may be derived. Likewise, a total photon energy (E_{TOT}) may be obtained from simple considerations of the energetics of the reactions in this neutron energy range. From the quotient of these two quantities, an average multiplicity (M_γ) of photons is obtained. The product of the multiplicity by the sum of the cross sections for the photon producing reactions yields a photon production cross section and the spectrum may be obtained from the normalized spectrum function. Extensions of the formalism to include fission reactions and anomalous production of single lines are discussed. Comparisons with experiment show an average deviation ($100 \times (\sigma_{calc}-\sigma_{exp})/\sigma_{exp}$) of 18 percent. (auth)

5766 THEORY OF DOPPLER BROADENING OF NEUTRON RESONANCES. Purohit, S. N.; Shea, T.; Kang, S. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. pp 1021-9 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

The Doppler broadening of neutron resonances is discussed using the Van Hove time integral representation of the reaction cross section. This formalism was applied to study the line shape of the capture, fission, scattering, and interference resonances. The Doppler broadening of p-wave resonances and the temperature coefficient of the cross section [$T(d\sigma/dT)$] were also studied. In addition, the formalism was extended to obtain the Doppler broadening of multilevel results of the Rosenfeld-Humblet theory. The final expressions involve the multilevel and temperature-dependent parameters. All the cross-section results were presented in terms of the ϕ_n integrals, expressible in terms of the resonance line shape functions ψ and χ, using the modified short collision time expansion. (auth)

5767 RECENT DEVELOPMENTS IN THE AUTOMATED COMPILATION AND PUBLICATION OF NEUTRON DATA. Pearlstein, S. (Brookhaven National Lab., Upton, N. Y.). pp 1041-8 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

The activities of the National Neutron Cross Section Center at Brookhaven National Laboratory are outlined, with emphasis on the development of procedures for entering, checking, and publishing data. The usefulness of computer graphics in these activities is noted. (D.C.W.)

5768 AUTOMATED EVALUATION OF EXPERIMENTAL DATA. Alter, Harry (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. pp 1049-66 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

An automated data evaluation system that will encompass all the operations from the generation of theoretical data to the final evaluated cross-section libraries is discussed. The system relies heavily on the use of CRT displays and computer graphics. (D.C.W.)

5769 PRINCIPLES OF CROSS-SECTION EVALUATION. Schmidt, J. J. (Kernforschungszentrum, Karlsruhe, Ger.). pp 1067-81 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

The principal methods used in the evaluation of neutron cross sections and parametric data in the thermal, resonance, and fast regions are discussed. For simplicity, only medium-weight and heavy nuclei are considered. (D.C.W.)

5770 NEUTRON DATA COMPILATION AT THE INTERNATIONAL ATOMIC ENERGY AGENCY. Lemmel, H. D.; Attree, P. M.; Byer, T. A.; Good, W. M.; Hjaerne, L.; Konshin, V. A.; Lorenz, A. (IAEA, Vienna). pp 1083-7 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

The present status of the neutron data compilation center of the IAEA Nuclear Data Unit, which is now in full operation is described. An outline is given of the principles and objectives, the working routines, and the services available within the two-fold functions of the Unit. A brief description of DASTAR, the Data Storage and Retrieval system, and of CINDU, the data Catalog of the IAEA Nuclear Data Unit, is given. (auth)

5771 THE ENEA NEUTRON DATA COMPILATION CENTRE. Bell, Victor J. (European Nuclear Energy Agency, Gif-sur-Yvette, France). pp 1089-92 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

The activities of the CCDN in the collection and dissemination of neutron data are outlined. (D.C.W.)

5772 AN INTEGRATED SYSTEM FOR PRODUCING CALCULATIONAL CONSTANTS FOR NEUTRONICS AND PHOTONICS CODES. Howerton, R. J. (Univ. of California, Livermore). pp 1093-5 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

Input constants for neutronics and photonics calculations are derived from files of evaluated neutron and photon cross sections which are based largely upon compilations of experimental data. Of course, the objective of neutronics and photonics calculations is to obtain reliable values for a spectrum of measurable characteristics of more or less complicated engineered configurations. A system that is comprised of a data file of experimental values

associated with neutron induced reactions, an evaluated neutron cross section file for 75 isotopes and elements, an evaluated photon cross section file for 87 elements, an evaluated library of light charged particle reactions, and sundry processing codes required for producing calculational constants for Monte Carlo, discrete ordinate, diffusion approximation, and other transport approximation neutronics and photonics codes is described. In addition, special Monte Carlo codes are used for checking the validity of the evaluated data files. The compilation of experimental neutron data is linked to its bibliography by arbitrary accession numbers. The components of that part of the system which deals with experimental neutron values include the data compilation, two bibliographic listings, one ordered by alphabetical arrangement of the citation, the other by accession number, an author index, and three indexes or digests of the data compilation. (auth)

5773 COMPUTER FILE OF RESONANCE DATA. Fuketa, T.; Nakajima, Y.; Okamoto, K. (Japan Atomic Energy Research Inst., Tokyo). pp 1097-1100 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

A computer program to make a computer file of resonance data (COMFORD) was prepared. In the COMFORD, the neutron resonance widths, average level spacings, strength functions, etc., are stored in a magnetic tape in order of atomic number. Different blocks of data for the same atomic number are stored in order of publication date and a control number which facilitates the identification of a data block. Symbols, which are equivalent to certain comments, can be attached to the individual numerical data in order to give an idea about the quality of the data, and these symbols may be used to classify the data when they are read out from the COMFORD. The primary purpose of the COMFORD is to use it as an input-data tape for variety of the computer analysis to investigate the statistical property of the neutron resonances; thorough and complete inclusion of all the published data is not intended for the present. (auth)

5774 INTERPRETATION OF THE CORRELATED ANALYSIS OF FISSION, TOTAL AND CAPTURE CROSS SECTION DATA. Adler, F. T.; Adler, D. B. (Univ. of Illinois, Urbana). pp 967-74 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

A program for the simultaneous analysis of total, fission, and capture cross sections is being developed to provide compatible sets of multilevel parameters useful for reactor applications and a basis from which further information of more fundamental physical interest can be derived. In particular, by combining results from a triple fit with analytical considerations, one can obtain indications for the spin assignments. The success of this technique hinges on the specific J values for the nuclide considered: for ^{239}Pu this procedure seems feasible while for ^{235}U the closeness of the J values may not permit this type of analysis. On the other hand, for ^{239}Pu, an analysis of total and fission cross section data alone has already shown that simple perturbation arguments are possible which lead to spin assignments consistent with experimental data. Results of this method are also presented. For a limited number of levels a perturbation method can be used to establish a correlation with R-matrix parameters. (auth)

5775 INTEGRAL TEST OF CAPTURE CROSS SECTIONS IN THE ENERGY RANGE 0.1 TO 2 MeV. Fabry, A.; De Coster, M. (CEN, Mol, Belgium). pp 1263-9 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

As a first step in a long-term applied research program under consideration in relation with the development of the German fast breeder prototype, capture cross sections averaged over the ^{235}U thermal fission neutron spectrum were measured by the activation technique for a few nuclides; they most often were found to disagree with earlier similar studies. The important features of the present method are briefly discussed. Included is a criticism of the uncertainties in the ^{235}U thermal fission spectrum itself, mainly based on recent integral studies and on new measurements of the ^{238}U(n,f) and ^{235}U(n,f) average cross sections using fission track detectors. The resulting average capture cross sections are compared with evaluated differential data. (auth)

5776 FAST NEUTRON CROSS SECTIONS: keV TO MeV. Cox, S. A. (Argonne National Lab., Ill.). pp 701-27 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

The status of absolute neutron capture cross sections is reviewed; and systematic behavior observed in (n,p), (n,α), and (n,2n) is discussed, including effects of shell closure. Some recent inelastic scattering data obtained both by time-of-flight techniques and by Ge(Li) techniques are discussed. The role of polarization measurements in determining parameters for nuclear models is also briefly discussed. Some comments on the roles of the cross-section measurer, user, and evaluator are also included. (D.C.W.)

5777 NEUTRON CROSS SECTIONS AND TECHNOLOGY. Proceedings of a Conference, Washington, D. C., March 4-7, 1968. Goldman, D. T. (ed). National Bureau of Standards Special Publication 299, Volume II, Sessions E-H. Washington, D. C., National Bureau of Standards, 1968. 718p. GPO $10.50 per set of 2 volumes. (NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2)).

Separate abstracts were prepared for 47 of the 65 papers included in this volume. The other 18 papers have previously appeared in NSA and may be located by referring to CONF-680307 in the report number index. (D.C.W.)

For abstracts of individual papers see: 5760-5778, 5823-5828, 5853-5855, 5889-5902, 5966-5969, 6030, and 6031.

5778 NEUTRON CROSS-SECTION MEASUREMENTS IN THE RESONANCE REGION. Moxon, M. C. (Atomic Energy Research Establishment, Harwell, Eng.). pp 641-68 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

The measurement of total, capture, and scattering cross sections can now be made with high resolution and accuracy up to neutron energies of several kilovolts. These measurements can be analyzed by the shape and area techniques to give accurate values of the resonance parameters for all but the very small resonances. Some of the problems, advantages and disadvantages of the various techniques used in the measurements and analysis will be discussed together with some recent measurements of neutron cross sections in the resonance region. (auth)

5779 SIGNIFICANCE OF NEUTRON DATA TO FAST REACTOR POWER PLANT DESIGN. Greebler, P.; Hutchins, B. A.; Wolfe, B. (General Electric Co., Sunnyvale, Calif.). Contract AT(04-3)-189. pp 291-310 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

An evaluation of the sensitivity of physics parameters and fuel costs of fast power reactors indicates that combined current data uncertainties produce about a ±0.15 mill/kwh uncertainty in fuel cost for a sodium-cooled fast reactor whose design has not been severely limited by requirements on the sodium void and Doppler reactivity effects. The uncertainty in physics parameters and fuel cost for steam-cooled fast reactors is about the same as for sodium coolant. Fissile breeding with steam-cooled fast reactors is jeopardized by the possibility of appreciably adverse nuclear data, whereas adequate breeding gain appears assured for sodium-cooled systems. For a sodium-cooled reactor that must satisfy stringent sodium void and Doppler reactivity requirements, the combined data uncertainties produce about a ±0.25 mill/kwh uncertainty in fuel cost. The current large uncertainty in the ^{239}Pu alpha value below 15 keV is the largest single contributor to the over-all fuel cost uncertainty, with the uncertainties in ^{238}U radiative capture cross sections and ^{239}Pu $\bar{\nu}$ being next in importance. A set of targets for nuclear data accuracy is recommended, on the basis of the calculated sensitivity of fuel cost to specific data uncertainties, which would reduce the calculated fuel cost uncertainty to about ±0.03 mill/kwh. Design modifications and associated development programs to improve fuel and heat transfer-fluid flow performance will be required, even for a sodium-cooled fast reactor, in the event of appreciably adverse nuclear data, if specific performance targets, such as low fissile doubling time (~10 years), are to be achieved. The uncertainties in performance, date of introduction, and need for additional development of fast reactors due to data uncertainties have large enough economic implications for the total reactor economy to justify an intensive effort to reduce these uncertainties. (auth)

5780 FISSION PRODUCT CROSS SECTION AND POISONING IN FAST REACTORS. Benzi, V. (CNEN, Bologna). pp 311-14 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

The neutron cross sections for radiative capture by fission product nuclei can be estimated in the unresolved resonance region by using the statistical model and the experimental data available. These estimates can be used to define pseudo-fission-product cross sections which are very useful for fast reactors calculations concerning long-term reactivity changes, breeding gain, etc.. The properties of these pseudo-fission-product cross sections are discussed both for ^{235}U and ^{239}Pu. It is shown that for energies above ~1 keV, the natural elements Pd and Pt can be reasonably adopted as mock-fission-products for ^{235}U and ^{239}Pu, respectively, as far as neutron absorption is concerned. (auth)

5781 THE (n,γ′) AND FISSION REACTIONS AS POSSIBLE SOURCES OF LOW-ENERGY NEUTRONS IN FAST CRITICAL ASSEMBLIES. Parker, K.; Pendlebury, E. D.; Shepherd, J. P.; Stanley, P. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 315-22 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. D., National Bureau of Standards, 1968.

At the Washington Conference on Neutron Cross Section Technology, March 22-24, 1966, Moldauer presented calculations of the (n,γn′) cross section of several nuclides including U238. In this process neutron re-emission follows a fairly low-energy gamma ray transition in the compound nucleus, and there results a continuous spectrum of relatively low-energy neutrons peaking at an energy typically several tens of keV. It has been suggested that this reaction could enhance the low-energy portion of calculated fast reactor spectra and this paper describes a simple investigation of this possibility. It was also convenient and logical to consider possible uncertainties in the low energy tail of the fission spectrum at the same time since many more neutrons will have fission reactions in a reactor system than (n,γn′) reactions. (auth)

5782 FISSILE DOPPLER EFFECT MEASUREMENT DATA AND TECHNIQUES. Till, C. E.; Lewis, R. A. (Argonne National Lab., Ill.). pp 323-36 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

Reactivity measurements in critical assemblies of the Doppler effect in fissile materials ideally measure a quantity of direct interest—the difference between the fission and absorption components directly in the flux and adjoint spectra of interest. In practice, however, the Doppler effect can be obscured by the effect of thermal expansion of the material. The systematics of the reactivity effects of expansion for ^{233}U, ^{235}U, ^{239}Pu, and ^{241}Pu are discussed. It is shown that the differences in their cross section variation with energy cause their expansion effects to differ markedly from each other in magnitude, in variation with sample density and with spectrum. Methods of minimizing the effects of sample expansion on Doppler effect measurements by spectrum and sample density considerations are discussed. Residual expansion effects are evaluated by use of samples with differing expansion properties. Precise experimental Doppler effect data in fast reactor spectra are presented that demonstrate excellent consistency in the Doppler effect inferred from samples expanding in different ways. An analysis is presented showing the degree of agreement given by various cross section averaging treatments of the ^{235}U resonance parameters. (auth)

5783 NEUTRON CROSS SECTIONS AND TECHNOLOGY. Proceedings of a Conference, Washington, D. C., March 4-7, 1968. Goldman, D. T. (ed.). National Bureau of Standards Special Publication 299, Volume I, Sessions A-D. Washington, D. C., National Bureau of Standards, 1968. 661p. GPO $10.50 per set of 2 volumes. (NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1)).

Separate abstracts were prepared for 44 of the 58 papers included. The other 14 papers have previously appeared in NSA and may be located by referring to CONF-680307 in the report number index. (D.C.W.)

For abstracts of individual papers see: 5779-5782, 5784-5793, 5830-5833, 5857-5860, 5912, 5916-5931, 5972, and 6001-6004.

5784 ROLE OF NEUTRONS IN ASTROPHYSICAL PHENOMENA. Fowler, William A. (California Inst. of Tech., Pasadena). pp 1-24 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

The neutron cross-section data that are needed to clarify the role of the γ-process and the s-process in nucleosynthesis are discussed. Some observations on the site of the s-process and on the role of neutrons in explosive nucleosynthesis are also included. (D.C.W.)

5785 FIELD OF SHIELDING TECHNOLOGY. Goldstein, Herbert (Columbia Univ., New York). pp 37-52 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

Neutron cross sections are required as input for transport calculations of various integral quantities required for shielding design as, for example, fast neutron doses. A survey is presented of the information currently available on the sensitivity of these shielding calculations to changes in the input cross sections. The discussion is concentrated on the total cross section, the energy spectrum of neutrons from inelastic scattering, and the representation of the angular distribution of elastically scattered neutrons. Evidence is presented for the need for high-accuracy measurements of total cross sections in the regions of minima. In nonhydrogenous shields where the nuclei are so heavy that inelastic scattering is the primary moderating mechanism, the details of the secondary neutron energy distribution may greatly influence the shielding performance. Finally, it is concluded that insofar as the scalar flux in homogeneous media is concerned, limited representations of the anisotropy of elastic scattering may be adequate. (auth)

5786 TEMPERATURE DEPENDENCE OF THE AVERAGE TRANSMISSION OF TUNGSTEN BETWEEN 2 keV AND 2 MeV NEUTRON ENERGY. Froehner, F. H.; Russell, J. L. Jr.; Young, J. C. (Gulf General Atomic, Inc., San Diego, Calif.). pp 61-6 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

The average transmission of natural W for neutrons with energies between 2 keV and 2 MeV was measured at room temperature and at 755°K. Below 100 keV a marked temperature dependence was observed. Around 10 keV the average transmission of the heated sample was about 16% lower than that measured at room temperature with a mean sample thickness of roughly one mean free path. The reason is the resonance structure of the total cross section of W in this energy region. The Monte Carlo self-shielding code SESH was used to calculate the effect from level statistics (strength functions, mean level spacings, Wigner and Porter-Thomas distributions). It was found that in order to reproduce the data one has to use strength functions which are considerably higher than published values, and correspondingly small effective nuclear radii. (auth)

5787 NEUTRON CROSS SECTIONS: THE FIELD OF RADIATION DAMAGE. Wechsler, M. S. (Oak Ridge National Lab., Tenn.). pp 67-83 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

Theoretical and experimental aspects of radiation damage are reviewed with special emphasis on the roles of neutron cross section and energy spectrum. Radiation damage to metals is due to the production of lattice defects (atom displacements) caused by collision or recoil events or the introduction of foreign atoms by transmutation reactions. Nonmetals are also affected by ionization and electronic excitation. The basic theory of displacement production is outlined, which leads to an overestimate of the neutron radiation damage in comparison to that observed experimentally. Various elaborations on the basic theory leading to reduced displacement production are then described. These include ionization losses, anisotropy of neutron scattering, forward scattering in the collision cascade, channeling and focusing, and dynamic and thermal annealing. Other special factors are displacements due to inelastic neutron scattering and capture (n,γ) recoils. Finally, the consequences of radiation damage are discussed. Two types of radiation embrittlement are of particular importance in reactor

technology: grain boundary embrittlement in fuel cladding alloys and the increase in the ductile-brittle transition temperature in ferritic pressure-vessel steels. (auth)

5788 PRODUCTION OF s-NUCLEI FROM e- AND r-SEED NUCLEI BY A FIXED NEUTRON FLUX. Amiet, J. P.; Zeh, H. D. (Univ., Heidelberg). pp 85-8 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

The s-process of nucleosynthesis assumes that part of the nuclei with A > 62 are produced in a slow neutron capture chain from iron seed-nuclei (e-nuclei) in red giant stars. Experimental data of neutron capture cross sections support the first part of this hypothesis. It is pointed out, however, that better agreement with the best data available to us may be obtained in a simpler way. Starting with the iron group nuclei and in addition with the nuclei which may be produced by β^--decay ("r-nuclei") as a seed, one is able to reproduce approximately the empirical abundances by irradiating the seed nuclei by a uniform neutron flux. The agreement may be improved if part of the s-abundances are assumed to have been present already in the seed. This result indicates that the s-process is only a secondary process, thus shifting the main burden of nuclear synthesis to the production of the seed nuclei. The abundance distribution of heavy nuclei ($A \gtrsim 63$) definitely shows the existence of at least three abundance groups. The most abundant group consists of just those nuclei which can be produced by β^- decay from nuclei lying on the neutron-rich side of the mass valley. The second group contains the nuclei which are shielded against β^- decay but which may be produced by neutron capture if the time between two capture processes is large compared to β^- decay times. The property of the second group gives information about its history. The correlation between abundances and neutron capture cross sections which exists for this group strongly supports the assumption of a slow neutron capture process ("s-process"). This empirical correlation has become definite with the determination of Maxwell-averaged capture cross sections for several pure isotopes. It states that the products oH of cross sections and abundances form a smooth function of atomic weight A. (auth)

5789 NEUTRON FLUX MEASUREMENTS. Batchelor, R. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 89-110 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

A review of methods of flux measurement for the determination of neutron cross sections is presented. Flux measurements based directly on cross-section values are discussed in detail, but absolute methods of flux measurement are also considered. The measurement of a unidirectional monoenergetic flux is emphasized. (D.C.W.)

5790 DEVELOPMENTS IN STANDARD NEUTRON CROSS SECTIONS. Gibbons, J. H. (Oak Ridge National Lab., Tenn.). pp 111-24 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

Neutron cross section "standards" are reviewed with emphasis on reaction cross sections such as fission and capture. Special attention is given to $^{10}B(n,\alpha)^7Li^*$, ^7Li since this reaction is one of the best means of comparing intermediate and fast neutron cross sections with thermal values. Recent measurement of other "standard" cross sections are also discussed, and recommendations for additional experiments are given. (auth)

5791 EXPERIMENTAL TECHNIQUES IN ABSOLUTE MEASUREMENTS OF THE FISSION NEUTRON YIELD. De Volpi, A. (Argonne National Lab., Ill.). pp 183-92 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

From a recent study of current values of the fundamental fission parameters, underlying characteristics of the various neutron yield measurements have been isolated and examined for susceptibility to systematic error. One may classify these experiments into two categories, gated and non-gated, with variations in each group. Certain weaknesses of each method can be distinguished, and efforts made to evaluate or remedy the possible sources of error are examined. New published and unpublished data on $\nu(^{235}U)$ and $\nu(^{252}Cf)$ can be brought into the picture. An evaluation has been made of the prospects for improvements based on new techniques in neutron detection, particularly with the manganese bath. It is possible to develop some conclusions with respect to likely achievements in precision for these nuclear standards in comparison with other fission parameters. (auth)

5792 ADVANCES IN ACCURATE FAST NEUTRON DETECTION. De Volpi, A.; Porges, K. G. (Argonne National Lab., Ill.). pp 213-24 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

The manganese bath is presently the leading technique used to obtain the highest precision when neutrons in the energy range of 1 keV to 10 MeV are counted with accuracies in the order of 1%. Examples of such experiments are absolute measurements of the fission parameters ν and η. Recent improvements in the manganese bath, entailing continuous flow through an annular NaI(Tl) crystal, have resulted in greatly augmented efficiency, in our case producing 1.6×10^{-3} counts/neutron at a background level of about 30 counts/sec. One limitation, though, is in application to experiments involving fluctuating neutron backgrounds (nuclear reactors and accelerators). With a half-life of 2.58 h, the cycle time for full manganese irradiation and decay is in the order of two days. A study of possible substitutes with shorter half-lives demonstrates that the sulfate of vanadium (3.77-m half-life) satisfies the various chemical, isotopic, cross-section, and radiation requirements. Besides offering a one-hour full-cycle time, the vanadium bath has a figure of merit, in terms of relative efficiency per neutron, just about half that obtained from the manganese system. Supporting experiments have established the conditions required for use of vanadium. (auth)

5793 SPATIALLY CONTINUOUS NEUTRON FLUX PLOTTING WITH SPARK CHAMBERS. Porges, K. G.; Managan, W. W.; Kaiser, W. C. (Argonne National Lab., Ill.). pp 247-52 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

Wire spark chambers yielding signals from which the spark location may be inferred within 0.1 cm have been recently developed for high energy physics experiments. With the addition of a fission foil, a single wire counter of this general type may be incorporated in a long tube of modest diameter, suitable for insertion in an available reactor or critical assembly instrument channel, and used to obtain the neutron flux profile with continuous spatial resolution. In addition to the advantages of resolution and speed, this device is relatively temperature and radiation insensitive and may thus be permanently sited to allow repeated flux profile measurements. The fission foil is self-calibrating: alpha tracks due to the natural alpha activity of the fissionable coating may be registered simply by increasing the applied voltage. The space resolution obtainable with such an instrument can be kept to a few millimeters by optimizing the geometry, such that only fission fragments emitted within a certain small angle to the foil normal are registered. The deionization time required after each spark limits the maximum count rate to the order of 10^3/sec. Preliminary results obtained with a prototype instrument are presented. (auth)

5794 NEUTRON WAVE PROPAGATION IN A HEAVY WATER, NATURAL URANIUM, SUBCRITICAL ASSEMBLY. Dunlap, Johnny Hall. Gainesville, Fla., Univ. of Florida, 1967. 287p.

Thesis.

Propagation of neutron waves in a multiplying medium was studied experimentally, and the resulting dispersion law was compared with that predicted by a two-group diffusion theory model, and a Fermi age diffusion model. Thermal neutron wave propagation in a subcritical assembly was studied via numerical Fourier analysis of a thermal neutron pulse of low spatial harmonic distortion introduced through one boundary of the assembly. One detector explored the axis of the assembly and supplied a description of the pulse in the time domain for input to a 1024-channel analyzer. A second detector served to monitor the source strength for each run, providing a means of normalizing data taken at different positions. Corrections for counting resolution losses and background were given careful attention. A computer code performed the Fourier analysis of the pulse, giving amplitude and

phase information as functions of frequency for each detector position. The experimental dispersion law was determined by further analysis of this output to obtain the real and imaginary parts of the inverse relaxation length of the Fourier components. Since an almost perfect fundamental spatial mode had been obtained for the source pulse in the experiment, the corresponding theoretical calculations were specialized to this mode in the transverse directions. The source neutrons were assumed to vary sinusoidally in time, and were introduced into the assembly through the XY plane at Z = 0. In the two-group treatment, the model led to an equation for a buckling-like term from which the parameters describing attenuation and phase shift as functions of frequency could be found. The Fermi age calculations were based on a complex equation derived by R. B. Perez, which yielded two real, coupled, transcendental equations. The experimentally determined dispersion law is a smooth function of frequency and both the real and imaginary parts of the inverse relaxation length increase with increasing frequency in the range of frequencies studied. The calculated dispersion laws from both models agree in general trend with that of the experiment except for a dramatic failure of the two-group theory for frequencies over 350 cps. Effects of the slowing-down process are important at high frequencies. (That the Fermi age theory describes the high frequency behavior in a more correct fashion than the two-group treatment is probably a consequence of the more accurate description of slowing-down in the age theory.) Since neither model gives entirely satisfactory agreement with the experiment, it appears that the thermalization effects should be included to describe the dispersion law of well-moderated systems. The dispersion law poses a severe test to a theoretical model. In addition to the measurements made with the loaded assembly, the dispersion law for heavy water without fuel was determined, and further analysis of the dispersion data yielded the following experimental values for the diffusion coefficient and the diffusion cooling coefficient, respectively: $D_0 = (1.996 \pm .002) \times 10^5$ cm^{2}sec^{-1}, and $C_0 = (3.0 \pm .381) \times 10^5$ cm^4 sec^{-1}. (Diss. Abstr.)

5795 ANGULAR AND ENERGY DISTRIBUTIONS OF SLOW NEUTRONS IN PENTANOL. Rapeanu, S.; Iliescu, N. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 13: 287-9 (1968).

Angular and energy distributions of thermal neutrons incoherently scattered in pentanol were measured using a crystal triple-axis spectrometer. The data were analyzed in terms of the jump diffusion model. (J.N.R.)

5796 WE NEED MORE INTENSE THERMAL-NEUTRON BEAMS. Brugger, Robert M. Phys. Today, 21: No. 12, 23-30(Dec. 1968).

The development of thermal neutron sources is outlined, and the types of experiments that can be performed using more intense beams are discussed. (D.C.W.)

5797 EXPERIMENTAL STATUS OF DATA ON DIFFERENT CROSS SECTIONS FOR REACTOR MATERIALS. Ghani, Abdul (Pakistan Inst. of Nuclear Science and Tech., Rawalpindi). J. Natur. Sci. Math., 8: 27-34(Apr. 1968).

The adequacy of the available neutron cross-section data for fast reactor materials is discussed with specific consideration of the total cross sections of Na and ^{239}Pu, the fission cross sections of ^{239}Pu and ^{235}U, the capture cross sections of ^{239}Pu and ^{238}U, and the inelastic scattering cross sections of ^{239}Pu and ^{238}U. Special cases are noted in which more accurate and comprehensive measurements are required. (D.C.W.)

5798 NEUTRON SPECTRUM IN AIR FROM A CRITICAL ASSEMBLY OF ^{235}U + Cu. Terekhin, V. A.; Kryzhanovskii, V. A.; Konnov, V. N.; Poretskii, L. B. At. Energ. (USSR), 25: 153-4 (Aug. 1968). (In Russian).

The spectrum of neutrons passing through air near the air-earth boundary is of interest for dosimetry purposes. The neutron source was a critical ^{235}U assembly which was surrounded with a Cu shell ~11 cm thick and suspended at a height ~7 m. The neutron spectrum was measured at a distance of ~100 m from the source at a height of ~3 m by a single-crystal scintillation spectrometer provided with gamma discrimination. The threshold of the spectrometer was ~200 keV at a gamma discrimination of ~10^{-5}. The instrument was calibrated with a Po–Be source also. The effect of resonances due to interactions of neutrons with air could be observed at neutron energies of 0.5, 0.9, and 1.5 MeV. (TTT)

5799 MATERIAL-GEOMETRICAL BUCKLING FACTOR METHOD FOR SOLUTION OF NEUTRON TRANSPORT EQUATION. Blinkin, V. L.; Novikov, V. M. At. Energ. (USSR), 25: 145-8(Aug. 1968). (In Russian).

A method is described for solving the transport equation which can be viewed as a generalization of the diffusion approximation. A single-group, stationary equation of neutron transport in integral form is considered for an unreflected reactor. It is assumed that the neutron flux depends on a single variable K (r,r') which involves the number of secondary neutrons per collision and the mean free path length of the neutrons over the reactor volume V. In the diffusion approximation the neutron flux satisfies a differential equation which can be approximated by the first three terms of a series. The coefficient in the equation depends only on the material properties of the medium (material buckling). The geometrical buckling is also taken into account only on introducing the boundary conditions. The equation is solved in analytical form. Values of the critical half-thickness (in units of mean free neutron path length) as a function of number of secondary neutrons per collision are tabulated and are compared with values calculated by more refined methods. The accuracy of the present method is comparable to that of the more complicated methods. (TTT)

5800 INTENSE NEUTRON GENERATOR. Fraser, J. S. (to Atomic Energy of Canada, Ltd.). Canada Patent 790,696. July 23, 1968.

A device is described for the production of a neutron flux of the order of 10^{19} neutrons/sec. A high-energy beam of protons accelerated and controlled by magnetic fields impinges on a liquid metal target of Pb–Bi eutectic alloy so that neutrons are produced by the "spallation" process. The liquid metal flows past the end of the beam tube in such a direction as to form a cavitation bubble which maintains a vacuum of about 10^{-5} torr. The liquid alloy is also used as a heat transfer medium. The cavitation bubble formed at the open end of the beam tube forms a windowless vacuum seal. The beam current may be up to 100 milliamperes and the energy involved of the order of 1 GeV. The total energy of the proton beam will be 60 MW of which approximately 35 MW will be removed as heat generated in the target. (F.S.A.) (Canada)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 5944 and 5961.

5801 INVESTIGATION OF THE REACTIONS ^{4}He(γ,p)^{3}H AND ^{4}He(γ,n)^{3}He. Gorbunov, A. N. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 8: 88-92(Aug. 5, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 148-54(Aug. 5, 1968).

Angular distributions and effective cross sections for the reactions ^{4}He(γ,n) and (γ,p) were measured at energies up to 260 MeV using a cloud chamber in a magnetic field of 10.5 kG. (J.W.R.)

5802 EXPERIMENTAL INVESTIGATIONS OF THE REACTION p(d,pp)n AND d(d,dp)n WITH 51.5-MeV DEUTERONS. Brueckmann, H.; Kluge, W.; Schaenzler, L. (Univ., Karlsruhe, Ger.). Z. Phys., 217: 350-72(1968). (In German).

The external beam of 51.5-MeV deuterons from the Karlsruhe isochronous cyclotron was used to investigate the three-particle reactions p(d,pp)n and d(d,dp)n. A kinematically complete experiment was performed by detecting, respectively, the two emitted protons and the proton and the deuteron in coincidence. The data for the reaction p(d,pp)n exhibit a pronounced final-state interaction between the outgoing neutron and one proton. This final-state interaction is mainly due to the n–p singlet interaction and the extracted n–p scattering length is $|a_s| = 19 \pm 2.5$ fm. In the investigation of the reaction d(d,dp)n, the angles were chosen so as to observe quasielastic deuteron-proton scattering predominantly. The data were analyzed in terms of the Chew-Low Spectator model; and by "on-energy-shell" extrapolation for the d–p cross section the value 7 ± 2.5 mb/sr was obtained. This value has to be compared with the cross section for free d–p scattering which was independently measured and the value obtained for the corresponding angle is 16 ± 1 mb/sr. (auth)

5803 ^{5}He LEVELS FROM A CHARGE-INDEPENDENT ANALYSIS OF ^{3}H(p,n)^{3}He. Werntz, Carl (Catholic Univ. of America, Washington, D. C. Naval Ordnance Lab., Silver Spring, Md.); Meyerhof, Walter E. Nucl. Phys., A121: 38-64 (1968).

An R-matrix analysis of the differential cross section and neutron polarization in the reaction ^{3}H(p,n)^{3}He is presented. Those levels are included which can be expected on the basis of shell-model arguments. In addition, the shell model is used to predict relative signs and magnitudes of reduced width amplitudes for the channels ^{3}He + n, ^{3}H + p, d + d, d + d', and d' + d' (d' refers to the

singlet deuteron). Positions and widths of states with $J^\pi(T)$ = $0^+(0)$, $2^+(0)$, $0^-(0)$, $0^-(1)$, $1^-(0)$, $1^-(1)$ (2 levels), $2^-(0)$, $2^-(1)$ are determined as well as the mixing coefficient of S = 0 and S = 1 amplitudes in the two T = 1, 1^- states. Isospin invariance is assumed throughout the analysis. (auth)

5804 THRESHOLD ELECTRODISINTEGRATION OF THE DEUTERON AT LOW MOMENTUM TRANSFER. Katz, L.; Ricco, G.; Drake, T. E.; Caplan, H. S. (Saskatchewan Accelerator Lab., Saskatoon). Phys. Lett., 28B: 114-15(Nov. 11, 1968).

The electrodisintegration of the deuteron near threshold was investigated by inelastic electron scattering. High-resolution spectra were obtained at momentum transfers of 0.35, 0.66, and 0.84 fm^{-1} and a scattering angle of 155°. The cross sections obtained agree with a potential model using a hard core in both initial and final states. (auth)

5805 SIMPLE RELATION BETWEEN RADIATIVE PION ABSORPTION AND MUON CAPTURE IN NUCLEI. Rho, M.; Sherwood, A. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Lett., 28B: 102-5(Nov. 11, 1968).

It is shown numerically that for light nuclei with $J = 0^+$, T = 0 ground state, the ratio of the total radiative 1S pion capture rate $\Gamma(\pi^-)$ to the total muon capture rate $\Gamma(\mu^-)$ is very nearly independent of nuclear structure, depending only on the ratio of squares of pionic and muonic atomic wave functions averaged over the nuclear dimension. (auth)

5806 ELASTIC SCATTERING OF PROTONS BY ^{4}He FROM 20 TO 28 MeV. Allison, P. W.; Smythe, Rodman (Univ. of Colorado, Boulder). Nucl. Phys., A121: 97-102(1968).

The absolute differential cross section for the elastic scattering of protons by ^{4}He was measured at about 50 angles from 7.5 to 174° at incident proton energies of 20.6, 23.3, 26.1, and 27.7 MeV with a typical accuracy of 2%. The excitation function was observed at c.m. angles of 22.6 and 114.6° from 20 to 28 MeV. The excitation functions have a well-defined resonance near 23 MeV corresponding to the previously known 16.6-MeV state of the compound nucleus ^{5}Li. (auth)

5807 SOME DEUTERON PROPERTIES WITH A POTENTIAL MATRIX DEDUCED FROM PHASE SHIFTS. Elliott, J. P.; Jackson, A. D. (Univ. of Sussex, Brighton, Eng.). Nucl. Phys., A121: 279-84(1968).

A number of deuteron properties are calculated using matrix elements of the nucleon–nucleon potential deduced directly from the experimental nucleon–nucleon phase shifts. (auth)

5808 ELASTIC SCATTERING OF ^{3}He FROM ^{12}C FROM 18 TO 24 MeV. Warshaw, S. I.; Buffa, A. J.; Barengoltz, J. B.; Brussel, M. K. (Univ. of Illinois, Urbana). Nucl. Phys., A121: 350-66(1968).

Angular distributions of ^{3}He nuclei elastically scattered from ^{12}C were taken at ^{3}He beam energies of 18.6, 20.0, 22.2, and 23.9 MeV and analyzed with a six-parameter local optical-model potential having either volume or surface absorption terms. It was not possible to account well for the data over the full angular range examined, but several sets of parameters which produced good predictions to the 20.0, 22.2, and 23.9 MeV data at forward angles were obtained by restricting the analyses to c.m. angles less than 85°. The real well depths of these parameter sets appeared to cluster around mean values of 75, 130, and 210 MeV. No substantial distinction seems evident in the quality of the fits between the volume and surface type analyses, but perhaps more consistent sets of real well depths were obtained in the surface case. The quality of the fits to the data appeared to improve with higher bombarding energy. (auth)

5809 RADIONUCLIZII. (Radionuclides). Sandru, P.; Topa, A. Bucharest, Edit. Acad. Republicii Socialiste Romania, 1968. 334p.

A systematic survey of the available data on the most commonly used radionuclides was made. Spectral data, decay schemes, and activation parameters are presented. (D.C.W.)

5810 PARTICLE-HOLE DESCRIPTION OF EVEN-PARITY T = 1 LEVELS OF ^{12}B. Guiasu, I.; Stancu, Fl. (Inst. for Atomic Physics, Bucharest). Nuovo Cim., 58A: 503-13(Nov. 21, 1968).

Calculations for the T = 1 levels of ^{12}B were performed using the particle-hole model. Particle-core and hole-core energies were treated phenomenologically by introducing experimental values relative to the ground state of ^{12}C. The residual two-body interaction was of the zero-range spin-dependent form. The results show fair agreement with experimental values. (J.W.R.)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 5586, 5746, 5805, 5809, 5912, 5934, 5944, 5956, and 5961.

5811 (COO–1120-73) GAMMA-RAY DECAY IN ^{19}F FROM ALPHA PARTICLE CAPTURE IN ^{15}N. Tolbert, D. D. (Kansas Univ., Lawrence. Nuclear Physics Lab.). Oct. 1968. Contract AT(11-1)-1120. 56p. Dep. CFSTI.

A study of the gamma-ray decay of the compound levels at 5339, 5474, and 5498 keV in ^{19}F was made with the ^{15}N(α,γ)^{19}F reaction. These levels occur at bombarding energies E_α = 1681, 1852, and 1883 keV, respectively. Unambiguous 7/2 and 9/2 spin assignments to the levels at 5474 and 2797 keV, respectively, and a tentative ½ spin assignment to the level at 5339 keV were made. Lifetime measurements were carried out on many levels in ^{19}F with the Doppler shift attenuation method. The lifetimes of the 1460- and 2797-keV levels were found to be 102 ± 35 and 246 ± 44 fs, respectively. The lifetime of the 2797-keV establishes a positive parity for this level and for the 5474-keV level. Comparison is made between these results and the predictions of current model calculations pertaining to ^{19}F. (auth)

5812 (COO–1120-75) LEVELS IN ^{15}N RESULTING FROM THE PROTON CAPTURE OF ^{14}C. Siefken, H. E. (Kansas Univ., Lawrence. Nuclear Physics Lab.). Sept. 1968. Contract AT(11-1)-1120. 98p. Dep. CFSTI.

The energy levels of ^{15}N were investigated by measuring γ angular distributions and triple correlations from the reaction ^{14}C(p,γ)^{15}N at proton energies of 250 to 650 keV. The measurements were centered around resonances observed at 261, 352, 527, and 634 keV. Resonance strengths, decay schemes, and branching ratios were determined for states in ^{15}N. Spin assignments were made or were confirmed for a number of the levels in ^{15}N below 10.5 MeV. (D.C.W.)

5813 (TID-24763) ANNUAL PROGRESS REPORT [ON GAMMA-RAY PRODUCTION CROSS SECTIONS AND ANGULAR DISTRIBUTIONS], FOR PERIOD ENDING JULY 31, 1965. (Texas Nuclear Corp., Austin). Aug. 15, 1965. Contract AT(40-1)-2791. 41p. Dep. CFSTI.

Gamma angular distributions and production cross sections for the reaction ^{10}B(n,α)^{7}Li and for fast neutron inelastic scattering by ^{10}B, Ce, ^{140}Ce, ^{59}Co, ^{54}Fe, and ^{208}Pb were measured. Information on levels in ^{140}Ce, ^{59}Co, and ^{89}Y was obtained. Preliminary γ spectra for neutron scattering by ^{239}Pu, ^{235}U, and ^{238}U were also obtained. (D.C.W.)

5814 LIFETIME MEASUREMENTS IN ^{18}Ne. Gill, R. D.; Robertson, B. C.; L'Ecuyer, J.; Bell, R. A. I.; Rose, H. J. (Oxford Univ.). Phys. Lett., 28B: 116-18(Nov. 11, 1968).

In order to complement the existing information on the mass 18 triad, the bound states of ^{18}Ne were investigated with the ^{16}O(^{3}He, n)^{18}Ne reaction. Lifetimes are reported, and the correspondence of the ^{18}Ne levels to their analogues in ^{18}O is given. A new level was found at E_x = 3576 keV. (auth)

5815 REACTION ^{10}B(γ,p)^{9}Be. Shardanov, A. Kh.; Yur'ev, B. A. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 8: 424-8(Sept. 1968). (In Russian).

Energy and angular distributions were measured for the photoprotons emitted by the nuclei ^{10}B irradiated by γ rays with maximal energy of 12.5 MeV. Nuclear photoplates were used. The energy distributions has maxima at 2.0 ± 0.1 and 2.4 ± 0.1 MeV and a not so definite maximum at ~3.5 MeV. The cross section of the reaction ^{10}B (γ,p) also has maxima, corresponding to the excitation of the nuclear levels at 8.8 ± 0.1, 9.2 ± 0.1, and possibly ~10.5 MeV. Analyzing the radiative widths and the angular distributions, one can establish the quantum numbers $I^\pi = 2^+$ and T = 1 for the 8.8-MeV level, $I^\pi = 3^+$ and T = 1 for the 9.2-MeV level, and positive parity and T = 1 for the 10.5-MeV level. (auth)

5816 STUDIES OF THE (d,α) REACTION ON THE ^{10}B AND ^{11}B NUCLEI IN THE DEUTERON ENERGY RANGE (0.8 TO 2.5 MeV). Comsan, M. N. H.; Farouk, M. A.; El-Kamhawy, A. A.; El-Tahawy, M. S. M.; Lvov, A. N. (Atomic Energy Establishment, Cairo). Atomkernergie, 13: 415-19(Nov.-Dec. 1968).

Excitation functions and angular distributions of the α particles leading to various nuclear states of ^{8}Be (ground and first) and ^{9}Be (ground and second) were measured in the deuteron energy range from 0.8 to 2.5 MeV. Excitation functions for the ^{10}B(d,α)^{8}Be reaction measured at seven angles from 30 to 150° show a smooth energy dependence. In the α_0-curves, broad resonance takes place at E_d = 1.10 MeV at forward angles. In the excitation curves of both

α groups from the $^{11}B(d,\alpha)^{9}Be$ measured at angles of 110 and 150° only a broad resonance is observed in the vicinity of $E_d \simeq 1.30$ MeV. Pronounced forward and backward peakings are observed in the angular distribution curves of both α_0 groups. Angular distributions of α_1 group from the $^{10}B(d,\alpha)^{8}Be$ reaction and the α_2 group from the $^{11}B(d,\alpha)^{9}Be$ reaction show a mixing between compound-nucleus and direct-interaction mechanisms. The angular distributions of $^{10}B(d,\alpha_0)^{8}Be$ reaction were analyzed in terms of two-nucleon pick-up and heavy particle stripping (HPS) mechanisms. For the $^{11}B(d,\alpha_0)^{9}Be$ reaction, the angular distributions were found to be in satisfactory agreement with the prediction of the two-particle pick-up theory alone. (auth)

5817 LIFETIME MEASUREMENTS IN MASS-15 NUCLEI. Gill, R. D.; Lopes, J. S.; Haeusser, O.; Rose, H. J. (Oxford Univ.). Nucl. Phys., A121: 209-23(1968).

The Doppler shift attenuation observed with a Ge(Li) gamma-ray detector was used to gain information on the electromagnetic decay rates of some bound levels of mass-15 nuclei. The values $\tau = 60 \pm 20$ fs and $\tau = 700 \pm 150$ fs were found for the mean life of the 7.563-MeV (^{15}N) and 7.276-MeV (^{15}O) levels, respectively. Upper lifetime limits were placed on the ^{15}N levels at 6.323, 7.154, 7.300, and 8.312 MeV and on the ^{15}O levels at 6.180, 6.789, and 6.857 MeV. (auth)

5818 AN ANALYSIS OF THE $^{12}C(d,\alpha)^{10}B$ REACTION IN THE ENERGY RANGE 9.2 TO 13.9 MeV. Klabes, R.; Baldeweg, F.; Stiller, G. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., A121: 113-27(1968).

Previous measurements of the $^{12}C(d,\alpha)^{10}B$ reaction at $E_d = 9.2$ to 13.9 MeV leading to the ground state and to the first, third, and fourth excited states of ^{10}B were analyzed in terms of the Glendenning two-nucleon transfer theory. The theoretical results are in poor agreement with experiment. At $E_d = 19.7$ MeV, better agreement was obtained between theory and experiment. Excitation functions of low-energy resolution, derived from differential cross sections in the (d,α), (d,d), and (d,p) channels, show resonances indicating that effects due to the intermediate nucleus ^{14}N play a role in the processes investigated. (auth)

5819 INELASTIC ELECTROMAGNETIC FORM FACTORS OF THE NUCLEUS ^{12}C IN CONTINUUM REGION. Dementii, S. V.; Afanas'ev, N. G.; Arkatov, I. M.; Vlasenko, V. G.; Gol'dshtein, V. A.; Kuplennikov, E. L. Yadern. Fiz., 8: 429-32 (Sept. 1968). (In Russian).

Inelastic form factors for the quasielastic scattering of electrons with energies 500 to 1000 MeV on the nucleons of ^{12}C were measured. The values obtained for the form factors are in agreement with the calculated quantities within experimental errors. (auth)

5820 THE EFFECT OF DEFORMED STATES ON β^- AND E1 DECAYS TO THE 0 AND 6.06-MeV 0^+ STATES OF ^{16}O. Jaffe, Robert L. (Princeton Univ., N. J.). Nucl. Phys., A121: 380-4 (1968).

The ratio of transition matrix elements for decays to the 0 and 6.06-MeV 0^+ states of ^{16}O is calculated. The transitions considered are the β^- decay of the ground state of ^{16}N and the E1 decay of the 13.1-MeV 1^- state in ^{16}O. Deformed 2p-2h and 4p-4h admixtures are included in the 0^+ states. The resulting ratios compare very favorably with recent experimental results. (auth)

5821 ENERGY DEPENDENCE OF THE α_1–γ ANGULAR CORRELATION IN THE REACTION $^{12}C(\alpha,\alpha_1\gamma)^{12}C$. Klein, S. S.; Meijer, A.; Poppema, O. J. (Technische Hogeschool, Eindhoven, Netherlands). Nucl. Phys., A121: 422-32(1968).

The α–γ angular correlation in the reaction $^{12}C(\alpha,\alpha_1\gamma)^{12}C$ was studied at seven bombarding energies between $E_\alpha = 18.0$ and 24.0 MeV. The target thickness was 0.7 MeV. At a fixed energy, the angular correlation pattern rotates when the scattering angle φ_α changes. The speed and direction of this rotation show an intricate dependence on E_α and φ_α. It appears that there is little correlation between the properties of the angular correlation and the differential cross section. (auth)

5822 SPIN AND LIFETIME OF THE 2797-keV LEVEL IN ^{19}F. Tolbert, D. D.; Cockburn, P. M.; Prosser, F. W. Jr. (Univ. of Kansas, Lawrence). Phys. Rev. Lett., 21: 1535-7 (Nov. 25, 1968).

Correlation measurements have resulted in an unambiguous $\frac{9}{2}$ spin assignment to the level in ^{19}F at 2797 keV. The lifetime of this level was measured with the Doppler shift attenuation method to be 246 ± 44 fsec, which establishes its positive parity assignment. (auth)

5823 PRECISION MEASUREMENTS OF EXCITATION FUNCTIONS OF (n,p), (n,α), AND (n,2n) REACTIONS INDUCED BY 13.5- TO 14.7-MeV NEUTRONS. Vonach, H. K. (Technische Hochschule, Munich); Vonach, W. G.; Muenzer, H.; Schramel, P. pp. 885-92 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

Relative cross sections for the reactions $^{19}F(n,2n)$, $^{24}Mg(n,p)$, $^{27}Al(n,\alpha)$, $^{48}Ti(n,p)$, $^{51}V(n,\alpha)$, $^{56}Fe(n,p)$, $^{65}Cu(n,2n)$, $^{107}Ag(n,2n)$, ^{106m}Ag, $^{115}In(n,2n)^{114m}In$, $^{181}Ta(n,2n)^{180m}Ta$, and $^{197}Au(n,2n)$ were determined. An overall accuracy (including all sources of systematic errors) of 1% was obtained for the ratios $\sigma(E_n)/\sigma(14.7$ MeV). Contrary to earlier measurements, but in agreement with recent results of Bormann, very little structure was found in the excitation functions. In addition ratios of the cross sections to the $^{27}Al(n,\alpha)$ cross section were determined for 8 of the reactions studied at 14.7 MeV with an overall accuracy of about 2 to 3%. (auth)

5824 MEASUREMENTS OF NEUTRON SCATTERING FROM ^{7}Li. Knitter, H. -H.; Coppola, M. (EURATOM, Geel, Belgium). pp 827-36 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.–299(Vol.2); CONF-680307–(Vol.2).

Angular distributions of neutrons elastically and inelastically scattered by ^{7}Li were measured at eight incoming energies between 1.12 and 2.30 MeV, using a fast neutron time-of-flight spectrometer. Data were corrected for flux attenuation and multiple scattering in the sample and for effects due to finite geometry. Differential cross section results are expressed in the form of Legendre polynomial expansions. Evaluated total and total inelastic cross sections are presented. (auth)

5825 THE $^{14}N(n,n'\gamma)$ REACTION FOR $5.8 \leq E_n \leq 8.6$ MeV. Dickens, J. K.; Eichler, E.; Perey, F. G.; Stelson, P. H.; Ashe, John; Nellis, D. O. (Oak Ridge National Lab., Tenn.). pp 811-19 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

Gamma-ray spectra were obtained for the reactions $^{14}N(n,n'\gamma)^{14}N$, $^{14}N(n,p\gamma)^{14}C$, and $^{14}N(n,\alpha\gamma)^{11}B$ for incident mean neutron energies $E_n = 5.8$, 6.4, 6.9, 7.4, 8.0, and 8.6 MeV. The gamma rays were detected using a coaxial Ge(Li) detector of 30-cc active volume. The detector was placed at 55 and 90° with respect to the incident neutron direction and was 77 cm from the sample. Time-of-flight was used with the gamma-ray detector to discriminate against pulses due to neutrons and background gamma radiation. The sample was 100 gm of Be_3N_2 in the form of a right circular cylinder. Data were also obtained using a 75-gm Be sample to provide an estimate of the background. The incident neutron beam was produced by bombarding a deuterium-filled gas with the pulsed deuteron beam of appropriate energy from the ORNL-6-MV Van de Graaff. The resulting neutron beam was monitored using a scintillation counter; a time-of-flight spectrum from this detector was recorded simultaneously with the gamma-ray data. These data were studied to obtain absolute cross sections for production of gamma rays from ^{14}N for the incident neutron energies quoted above. (auth)

5826 HIGH RESOLUTION TOTAL FAST NEUTRON CROSS SECTIONS ON SOME NONFISSIBLE NUCLEI IN THE ENERGY RANGE $0.5 \leq E_n \leq 30$ MeV. Cierjacks, S.; Forti, P.; Kopsch, D.; Kropp, L.; Nebe, J. (Kernforschungszentrum, Karlsruhe, Ger.). pp 743-54 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

The spectrometer at the Karlsruhe isochronous cyclotron was used to measure fast neutron total cross sections of a number of nuclides ranging from C to Bi. Bursts of 45-MeV (average energy) deuterons of ~1 nsec duration striking thick natural uranium targets yield a broad neutron spectrum. Neutrons were analyzed by time-of-flight. The analysis system includes a 57-m flight path, a 9-cm diameter × 1-cm thick NE213 liquid scintillator in connection with a zero-crossover tunnel-diode time-mark circuit and a digital time analyzer coupled with a CDC 3100 on-line computer as the recording system. The overall resolution in the present experiments was ≤0.03 ns/m. The high neutron intensity from the cyclotron permits rapid data accumulation. Typically 1% statistical accuracy was obtained in most of the 16000 data points in a 10 to 12 hr running time. In the energy-dependent cross section, significant fluctuations were observed up to several MeV. In the light elements C, O, Al, Na, S, fluctuations outside the statistical uncertainty range up to 10 MeV or more. For the elements Ca and Fe, fluctuations up to 6 to 8 MeV, and for Bi and Tl, up to 3 to 4 MeV, were found. In order to investigate the effects of fluctuations a statistical analysis was performed in some cases. (auth)

5827 GAMMA RAYS FROM INELASTIC NEUTRON SCATTERING IN NITROGEN. Conde, H. (Research Inst. of National Defence, Stockholm); Bergqvist, I.; Nystroem, G. pp 763-9 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

The gamma production cross sections of N was measured at three different incident neutron energies between 4.5 and 7 MeV. The gamma spectrometer was a 17-cc Ge(Li) detector. A time-of-flight technique was employed to suppress the background caused by neutron interactions in the Ge(Li) detector. The efficiency of the gamma spectrometer was measured with calibrated gamma sources and (p,γ) reactions. The primary neutron flux was measured with a proton-recoil telescope. Gamma lines of energies from 0.7 to 5.8 MeV were observed, with pronounced lines at 0.730, 1.637, 2.315, 5.104, and 5.834 MeV. Differential gamma production cross sections at 55° are given. (auth)

5828 TOTAL NEUTRON CROSS SECTIONS OF CARBON, IRON, AND LEAD IN THE MeV REGION. Schwartz, R. B.; Schrack, R. A.; Heaton II, H. T. (National Bureau of Standards, Washington, D. C.). pp 771-81 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

The total neutron cross sections of Fe and Pb were measured in the energy range 0.7 to 4.0 MeV. In addition, as a check on the method, the well-known C cross section was measured in the same energy range. The neutron time-of-flight method was employed, with the NBS electron linear accelerator as a pulsed neutron source. The neutron energy resolution was 0.3 to 0.16 nsec/m. The C data are in agreement with the earlier results from other laboratories, and the Pb data are in good agreement with recent measurements from Saclay and from Wisconsin in overlapping energy regions. A detailed comparison of the results obtained with those from other laboratories is presented. (auth)

5829 TOTAL NEUTRON-NUCLEI CROSS-SECTIONS AT 10 GeV/c. Engler, J. (Insititu fuer Experimentelle Kernphysik, Karlsruhe, Ger.); Horn, K.; Koenig, J.; Moennig, F.; Schludecker, P.; Schopper, H.; Sievers, P.; Ullrich, H.; Runge, K. Phys. Lett., 28B: 64-6(Oct. 28, 1968).

Total neutron cross sections were determined for He, Li, Be, C, Al, Fe, Cu, and Pb at an average neutron momentum of 10 GeV/c. The results agree very well with total proton-neuclei cross-sections at 20 GeV/c. The interaction radii inferred from the cross sections are in remarkable agreement with the half-density radii as obtained from electron scattering. (auth)

5830 NONELASTIC AND SOME INELASTIC CROSS SECTIONS IN ^{12}C AND ^{14}N AT 15.3 MeV. Hansen, Luisa F.; Anderson, John D.; Stelts, Marion L.; Wong, Calvin (Univ. of California, Livermore). pp 225-33 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

Neutron cross sections in ^{12}C and ^{14}N were measured at 15.3 MeV by means of the sphere transmission technique in conjunction with the time-of-flight facilities at Livermore. The carbon targets were solid spheres of 0.5, 1.3, and 3 mean free paths radius, while the nitrogen target was a spherical dewar of one mean free path. The analysis of the data was done using the Livermore Monte Carlo Neutron Transport Program. To obtain agreement with the data, a revision of some of the cross sections and respective angular distributions was required, which resulted in a dramatic improvement in the quality of the fits to the measured time spectra. Very good agreement with the experimental results in ^{12}C was obtained with a SORS calculation that includes a σ_t = 1340 mb, $\sigma_{n\alpha}$ = 550 mb, and an (n,n') cross section of 200 mb to the 4.43-MeV and 100 mb to the 9.6-MeV levels. The angular distribution for the 4.43-MeV level was taken from the literature, while the 9.6-MeV angular distribution was assumed to be isotropic. For ^{14}N fair agreement between the calculations and the measurements was obtained for the following cross sections: σ_t = 1570 mb and $\sigma_{n\alpha}$ = 706 mb. The (n,n') cross sections to the first 6 excited levels inclusive was 200 mb, while 446 mb accounted for the rest of the (n,n') cross sections. The non-elastic cross sections obtained for C and N, corrected for multiple scattering, were 554 ± 30 and 600 ± 30 mb, respectively. (auth)

5831 TOTAL NEUTRON CROSS SECTIONS OF ^{6}Li, ^{7}Li, AND LITHIUM FROM 10 TO 1236 keV. Hibdon, C. T.; Mooring, F. P. (Argonne National Lab., Ill.). pp 159-68 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

The total cross sections of ^{6}Li and natural lithium were measured by the transmission method for neutrons in the energy range 10 to 1236 keV, and the total cross section of ^{7}Li was extracted from the results. Except for a range of energies near 250 keV, the neutron energy spread was ~2 keV. No structure other than a large resonance in the cross section of ^{6}Li at 250 keV and in the cross section of ^{7}Li at 260 keV was observed. These two resonances were investigated by both flat-detection and self-indication techniques, in each case with neutron energy spreads of ~1 keV and ~8 keV. The measured peak height of each of these resonances disagrees with the theoretical value for any possible value of J. Furthermore, the self-indication values of the cross sections are significantly higher than the flat-detection values. These facts, together with the results taken with the narrower resolution width (~1 keV), suggest that both resonances may possibly contain fine structure. (auth)

5832 THE NONELASTIC CROSS SECTION OF BERYLLIUM FOR NEUTRONS FROM 2.3 TO 5.2 MeV. Eaton, J. R. P.; Walker, J. (Univ. of Birmingham, Eng.). pp 169-76 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

The nonelastic cross section of Be for neutrons was measured with the sphere technique at seven energies between 2.3 and 5.2 MeV; neutrons were obtained from the T(p,n) and D(d,n) reactions with the 5-MeV electrostatic accelerator at AERE Harwell. A ^{238}U fission chamber was used as a threshold detector, and measurements were made with and without Be shells of different thicknesses around it. A Monte-Carlo calculation of the spectrum of neutrons elastically scattered in the Be enables a correction to be made for those neutrons taken below the detector threshold by elastic, rather than nonelastic, scattering. The comparison between the Monte-Carlo results and those given by using the analytical methods of Bethe, Beyster and Carter shows that a multi-group analysis is necessary. The measured cross sections, corrected for the finite sizes of the detector and the source, are higher near threshold than earlier values. (auth)

5833 NEUTRON CROSS SECTIONS OF ^{6}Li IN THE KILOVOLT REGION. Farrell, J. A. (Los Alamos Scientific Lab., N. Mex.); Pineo, W. F. E. pp 153-8 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

The neutron total cross section of ^{6}Li was measured in the neutron energy range 50 to 650 keV using the $^{7}Li(p,n)^{7}Be$ reaction as a neutron source. The data were fitted by least squares with the single-level Breit-Wigner formula plus a 1/v term. The $^{6}Li(n,\alpha)$ cross section was computed from the resulting resonance parameters and was compared with experiment. (auth)

5834 LOW-ENERGY ELECTRON SCATTERING FROM THE 2.18 AND 3.56 MeV LEVELS OF ^{6}Li. Eigenbrod, F. (Institut fuer Technische Kernphysik, Darmstadt, Ger.). Z. Naturforsch., 23a: 1671-2(Oct. 1968).

From inelastic electron scattering cross sections, measured for momentum transfers q between 0.21 and 0.56 fm^{-1}, ground-state radiative widths ((4.31 ± 0.34) × 10^{-4} eV for the 2.18-MeV E2 transition) and transition radii were deduced. (auth)

5835 THE POLARIZATION OF THE NEUTRONS FROM THE $^{10}B(d,n_0)^{11}C$ REACTION FOR DEUTERON ENERGIES BELOW 3.0 MeV. Bruening, R. (Hamburg Univ.); Buesser, F. W.; Dubenkropp, H.; Niebergall, F.; Christiansen, J. Nucl. Phys., A121: 224-32(1968).

The angular distributions of the polarization of the neutrons from the $^{10}B(d,n_0)^{11}C$ reaction were investigated at average deuteron bombarding energies of 1.20, 1.65, 2.05, 2.50, and 2.90 MeV. The asymmetry of the neutrons scattered by helium was measured using a telescope of parallel-plate avalanche counters. The polarization was determined from the asymmetry values by means of the phase shifts for n-α scattering of Hoop and Barschall. At the same deuteron energies, the angular distributions of the differential cross section were measured with a time-of-flight spectrometer. DWBA calculations were tried for the angular distributions of the differential cross section and polarization averaged over the interval of the deuteron bombarding energies between 1.2 and 2.9 MeV. (auth)

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Refer also to abstracts 4830, 5746, 5765, 5805, 5809, 5813, 5823, 5826, 5828, 5829, 5865, 5873, 5897, 5924, 5934, 5941, 5944, and 5955.

5836 (INP–624) NUCLEAR GLORY EFFECT IN THE ELASTIC SCATTERING OF ALPHA PARTICLES ON ^{27}Al, ^{28}Si, ^{32}S, ^{39}K, ^{40}Ca, Ti AND ^{59}Co NUCLEI. Bobrowska, A.; Budzanowski, K.; Grotowski, Jarczyk, L.; Micek, S.; Niewodniczanski, H.; Strzalkowski, A.; Wrobel, Z. (Institute of Nuclear Physics, Krakow (Poland)). July 1968. 15p. Dep.

Angular distributions were measured for 27.5-MeV alpha particles scattered on ^{27}Al, ^{28}Si, ^{32}S, ^{39}K, ^{40}Ca, Ti, and ^{59}Co nuclei. The experimental data were fitted with the diffraction model in the region of forward angles and with the glory model for backward angles. (auth)

5837 EVIDENCE FOR A GROUND-STATE TRIPLET IN ^{45}Ti. Jett, J. H.; Jones, G. D.; Ristinen, R. A. (Univ. of Colorado, Boulder). Phys. Lett., 28B: 111-13(Nov. 11, 1968).

Measurements of γ rays following ^{45}Sc(p,n)^{45}Ti reaction together with neutron time-of-flight data provide convincing evidence for the existence of a ground-state triplet in ^{45}Ti at 0, 36.7, and 40.2 keV. (auth)

5838 STUDY OF A POSSIBLE 3^+ LEVEL IN ^{30}Si. Wildenthal, B. H.; Newman, E. (Oak Ridge National Lab., Tenn.). Phys. Lett., 28B: 108-10(Nov. 11, 1968).

Evidence is presented which indicates that a level in ^{30}Si at 5.22-MeV excitation has $J^\pi = 3^+$. (auth)

5839 NEW ISOTOPE ^{82}As. Mathew, P. J. (Inst. of Nuclear Sciences, Lower Hutt, New Zealand); McCallum, G. J.; Freeman, R. M. Phys. Lett., 28B: 106-7(Nov. 11, 1968).

Two new γ activities of energies 655 ± 0.5 keV and 817 ± 0.5 keV and half-life 15 ± 2 s were produced by irradiation of natural selenium and enriched ^{82}Se, with 16.4-Mev neutrons. These activities were assigned to the β^- decay of ^{82}As formed in the reaction ^{82}Se(n,p)^{82}As. (auth)

5840 PARTICLE-HOLE EXCITATIONS IN ^{88}Sr. Shastry, S. (State Univ. of New York Coll., Plattsburgh). Phys. Lett., 28B: 85-7(Nov. 11, 1968).

A finite-range force calculation was performed for the recently observed spectrum of ^{88}Sr. Collective quadrupole and octupole transition rates were also calculated without introducing any effective charge, and they were in fine agreement with the experiment. (auth)

5841 SHELL MODEL STUDY OF THE STRUCTURE OF ^{56}Ni. Wong, S. S. M.; Davies, W. G. (Univ. of Alberta, Edmonton). Phys. Lett., 28B: 77-8(Nov. 11, 1968).

The structure of ^{56}Ni is studied in a shell model space which allows up to four-particle excitations from the $f_{\frac{7}{2}}$ shell. (auth)

5842 RADIATIVE CORRECTIONS IN MUONIC ATOMS. Barrett, R. C. (Univ. of Surrey, Guildford, Eng.). Phys. Lett., 28B: 93-5(Nov. 11, 1968).

The Lamb shift and vacuum polarization correction in muonic atoms are calculated for a number of elements. (auth)

5843 INVESTIGATION OF ANOMALIES IN THE ELASTIC SCATTERING OF 13.6-MeV DEUTERONS ON ATOMIC NUCLEI WITH N = 50. Korostova, I. N.; Sokolov, L. S.; Tokarevskii, V. V.; Chernov, I. P.; Yatis, A. A. Yadern. Fiz., 8: 10-13(1968). (In Russian).

Differential cross sections were measured for the elastic scattering of 13.6-MeV deuterons on the nuclei of Se, ^{86}Sr, ^{89}Y, ^{93}Nb, ^{96}Mo, and Ru in the region of angles from 10 to 170°. An enhancement of the diffractional structure in the angular distributions and an increase of the total elastic cross section were detected in the region of the filled neutron shell with N = 50 for the nuclei ^{86}Sr, ^{89}Y, ^{93}Nb. The obtained angular distributions were analyzed in framework of the optical model. A correlation between the parameters of the optical model (W and a) and the anomalies in the angular distributions of the elastically scattered deuterons was observed. (auth)

5844 CROSS SECTIONS OF THE (n,p) AND (n,α) REACTIONS AT THE NEUTRON ENERGY OF 14.8 MeV. Levkovski, V. N.; Kovelskaya, G. E.; Vinitskaya, G. P.; Stepanov, V. M.; Sokolski, V. V. Yadern. Fiz., 8: 7-9(1968). (In Russian).

Twenty-four absolute cross sections of the (n,p) and (n,α) reactions on isotopes of S, K, Ca, Sc, Fe, Co, Ni, Rb, Sr, Y, Cs, Ba, La, and Ce were measured by means of the activation method. (auth)

5845 GAMMA RAYS FOLLOWING THE DECAY OF ^{75}Se. Nagpal, T. S. (Bishop's Univ., Lennoxville, Can.). Nucl. Phys., A121: 176-80(1968).

The gamma-ray spectrum of ^{75}Se was studied using lithium-drifted detectors. Seven new transitions were observed for the first time. The energies in keV and the relative intensities (indicated in parentheses) of the new gamma rays observed were 335.14(0.18), 415.10(2.76×10^{-2}), 485.58(3.68×10^{-3}), 528.55(1.46×10^{-2}), 535.79(9.34×10^{-3}), 543.03(1.40×10^{-2}), and 556.55(3.04×10^{-2}). The energies and relative intensities of other gamma rays in the decay were also measured. (auth)

5846 GAMMA-RAY ANGULAR CORRELATION STUDIES OF LOW-LYING LEVELS IN ^{23}Na. Sowerby, B. D.; Sheppard, D. M.; Olsen, W. C. (Univ. of Alberta, Edmonton). Nucl. Phys., A121: 181-90(1968).

Gamma-gamma correlations following the bombardment of ^{23}Na with 4.71 and 5.12 MeV protons were measured using method I of Litherland and Ferguson. Experiments were carried out on gamma rays cascading from the 2.08, 2.39, 2.71, and 2.98 MeV levels in ^{23}Na. The deduced spins of the 2.08 and 2.71 MeV levels are $\frac{7}{2}$ and $\frac{9}{2}$, respectively. The mixing ratios of the 0.44 → 0, 2.08 → 0.44, and 2.71 → 2.08 MeV gamma rays are −0.06 ± 0.04, −0.24 ± 0.07 and −0.02 ± 0.09, respectively. Evidence consistent with a spin assignment of $\frac{1}{2}$ to the 2.39 MeV level is presented. (auth)

5847 A NOTE ON DECAY OF ^{49}Cr. Barker, P. H.; Connor, R. D. (Univ. of Manitoba, Winnipeg). Nucl. Phys., A121: 128-30(1968).

Gamma-ray energies (keV) and intensities per positron decay were found to be 62.3 ± 0.1 (29 ± 3%), 90.6 ± 0.11 (30 ± 3%), and 152.9 ± 0.1 (14 ± 1.5%) with upper limits of 0.1% on previously reported γ-rays in the region of 610 and 840 keV. Energies, intensities, and log ft values of the positron branches to the levels in ^{49}V were deduced. (auth)

5848 THE L/K ELECTRON CAPTURE RATIO IN THE DECAY OF ^{65}Zn TO THE 1.114-MeV EXCITED STATE OF ^{65}Cu. McCann, M. F.; Smith, K. M. (Univ. of Glasgow). Nucl. Phys., A121: 233-40(1968).

The L/K electron capture ratio in the excited state decay branch of ^{65}Zn was measured directly by internal-source scintillation-counter techniques. The value for the ratio is 0.117 ± 0.007; comparison is made with determinations by other methods and the degree of correspondence of the result with theoretical predictions is discussed. (auth)

5849 ELECTRON ELASTIC SCATTERING ON NICKEL AND TIN ISOTOPES. Khvastunov, V. M.; Afanas'ev, N. G.; Afanas'ev, V. D.; Gulkarov, I. S.; Omelaenko, A. S.; Savitskii, G. A.; Khomich, A. A.; Shevchenko, N. G. (Physical-Technical Inst., Kharkov). Phys. Lett., 28B: 119-21(Nov. 11, 1968).

Differential cross sections were measured for the elastic scattering of 225-MeV electrons on ^{58,60,64}Ni and ^{112,118}Sn. The addition of 2p $\frac{1}{2}$ neutrons produces an increase of the charge radius practically in agreement with the $A^{\frac{1}{3}}$ law, whereas the addition of neutrons with higher orbital momentum produces a much smaller increase. (auth)

5850 THOMAS FORM OF THE SPIN-DEPENDENT OPTICAL POTENTIAL AND ASYMMETRY OF 20-MeV POLARIZED PROTONS. Sherif, H. (Univ. of Washington, Seattle); De Swiniarski, R. Phys. Lett., 28B: 96-8(Nov. 11, 1968).

Recently measured asymmetries produced in the inelastic scattering of 20.3 MeV polarized protons were analyzed in the DWBA collective model approximation. Substantial improvements are observed when the deformed spin-dependent optical potential is of the full Thomas form. (auth)

5851 NUCLEAR STRUCTURE STUDIES OF THE CHROMIUM ISOTOPES: THE ^{52,53}Cr(p,p'), ^{53}Cr(p,p'γ), ^{53}Cr(d,d'), AND ^{52}Cr(d,p) REACTIONS. Rao, M. N.; Rapaport, J.; Sperduto, A.; Smith, D. L. (Massachusetts Inst. of Tech., Cambridge). Nucl. Phys., A121: 1-37(1968).

The MIT-ONR electrostatic generator and the MIT multiple-gap spectrograph were used to study the level structure of ^{52}Cr and ^{53}Cr by means of the (p,p'), (p,p'γ), (d,d') and (d,p) reactions with proton and deuteron bombarding energies of 7.5 MeV. A total of 14 levels in ^{52}Cr and 26 levels in ^{53}Cr from the (p,p') reactions and 102 levels in ^{53}Cr from the (d,p) reactions are reported. Angular distributions of elastic and inelastic particle groups corresponding to the first five states in ^{53}Cr were obtained from both the (p,p') and (d,d') experiments. A comparison of the angular distributions of protons from the (d,p) reactions with calculations from zero-range DWBA yielded information on the orbital angular momentum of the transferred neutron and transition strengths for 27 levels in ^{53}Cr up to 4.7 MeV in excitation. The deduced (d,p) strengths are compared with shell-model sum-rule limits. The experimental results

from the five reactions investigated are compared with other experiments performed with higher bombarding energies. The properties of the low-lying levels in ^{53}Cr are of particular interest and are discussed in terms of theoretical calculations based on the shell model and also the weak-coupling model. (auth)

5852 EXCITATION ENERGIES OF LEVELS IN ^{34}S. Moss, C. E. (California Inst. of Tech., Pasadena). Nucl. Phys., A121: 285-8(1968).

A sulfur target enriched in ^{34}S was bombarded with 12-MeV protons, and the scattered protons were observed with a magnetic spectrometer. The excitation energies of 38 levels in ^{34}S were determined, and the results compared with previous results. (auth)

5853 SYSTEMATIC INVESTIGATION OF FAST NEUTRON ELASTIC SCATTERING. Holmqvist, B.; Wiedling, T. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 845-50 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

An experimental study was done of the angular distributions of elastically scattered neutrons from the elements Al, S, Ca, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, In, and Bi for several energies in the energy interval 1.5 to 8.0 MeV. The results were compared with optical-model calculations. Theoretical distributions were fitted to the experimental ones by using a diffuse spherical local optical-model potential including a spin-orbit interaction term. Optimum fits to the experimental distributions were evaluated in a search routine by varying five optical parameters, i.e., the real and imaginary potential depths, the nuclear radii, and the diffuseness parameter of the real potential. Average parameters were thus obtained for each individual element. The dependence of the real potential depth on the nuclear symmetry parameter (N-Z)/A was also studied at the neutron energies 6, 7, and 8 MeV, yielding a value of 50 MeV for the symmetry term. (auth)

5854 THE STRENGTH FUNCTIONS S_0 AND S_1, THE TOTAL RADIATIVE WIDTH Γ_γ AND THE MEAN LEVEL SPACING $\bar{D}$ AS A FUNCTION OF MASS NUMBER AND SPIN VALUE. Morgenstern, J.; Alves, R.; de Barros, S.; Julien, J.; Samour, C. (CEN de Saclay, Gif-sur-Yvette, France). pp 867-74 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

The neutron total cross section was measured for about 30 elements from ^{51}V to ^{209}Bi. Time-of-flight methods were used with two different flight paths: 103 m and 199.3 m. The best resolution was equal to 0.19 ns/m. The resonance parameters at the potential scattering cross section were determined by shape analysis of the resonances, using single and multilevel formulas. In some cases, p-wave resonances were identified by noting the absence of interference between resonant and potential scattering due to the very low value of the p-wave potential scattering cross section. (auth)

5855 NEUTRON RADIATIVE CAPTURE IN THE keV REGION. Hockenbury, R. W.; Bartolome, Z. M.; Moyer, W. R.; Tatarczuk, J. R.; Block, R. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. pp 729-34 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

Resonance parameters and resonance capture areas were obtained for Na, Al, Fe and Ni in the energy range from 200 eV to 300 keV. Radiative widths were determined for five resonances in Fe, two resonances in Al, two resonances in Na, and one resonance in Ni. Where comparisons can be made, the agreement between the present results and other investigations is satisfactory. In Al, the radiative widths are not constant; that of the 35-keV resonance is 2.8 ± 0.3 eV while that of the 5.88-keV resonance is at most 1.0 eV (if g is assumed equal to $\frac{1}{4}$ for the 5.88 keV resonance). For ^{56}Fe and ^{57}Fe, the radiative widths differ by a factor of two to three from resonance to resonance in the same isotope. The weaker resonances in Fe and Ni can be attributed to p-wave neutrons; and from the capture data, a p-wave strength function can be determined. In both Ni and Fe, the p-wave strength functions are an order of magnitude smaller than those predicted by the optical model. (auth)

5856 REORIENTATION MEASUREMENT IN ^{24}Mg. Bamberger, A.; Bizzeti, P. G.; Povh, B. (Max-Planck-Institut fuer Kernphysik, Heidelberg. Univ., Heidelberg). Phys. Rev. Lett., 21: 1599-1601(Dec. 2, 1968).

The reorientation effect in Coulomb excitation with ^{32}S ions was used to deduce the static quadrupole moment of the first excited $J^\pi = 2^+$ state in ^{24}Mg. The value obtained in this experiment is $Q_2^+ = -0.26 \pm 0.08$ b. (auth)

5857 THE ^{55}Mn RESONANCE ACTIVATION INTEGRAL. Sher, Rudolph (Brookhaven National Lab., Upton, N. Y.). pp 253-7 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

The infinite dilution resonance capture integral of ^{55}Mn was carefully remeasured, using cadmium ratio techniques. The measurement was done in beam geometry at the BNL Graphite Reactor. Corrections for scattering effects in the Cd filters and the contribution to the activation of non-beam neutrons were made. The 1/E-ness of the spectrum was verified by means of previous fast-chopper data taken at the same beam. The results for the resonance integral was 14.4 ± 0.5 barns, based on a Au resonance integral value of 1565 ± 30 barns. There have been about a dozen previous measurements of the Mn resonance integral, with values ranging from 11 to 18 barns. The present result agrees well with two measurements in which particular care was taken to determine the neutron spectrum; because of the high value of the principal resonance energy in Mn (336 eV), the measured integral is particularly sensitive to spectral effects, and it is suggested that this is what is chiefly responsible for the large spread of values previously determined. (auth)

5858 NEUTRON DIFFERENTIAL CROSS-SECTION EVALUATION BY A MULTIPLE FOIL ACTIVATION ITERATIVE METHOD. McElroy, W. N. (Battelle Memorial Inst., Richland, Wash.); Ulseth, J. A.; Berg, S.; Gigas, G.; Crockett, T. B. Contracts AT(45-1)-1830; AT(11-1)-Gen-8. pp 235-45 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968. (BNWL-SA-1527).

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

A multiple foil activation iterative method is being studied and used to evaluate differential cross sections for reactions useful for determining fast reactor neutron flux spectra. This multiple foil activation method involves irradiation of a selected set of detectors (usually 10 to 15), measurement of resultant activities, and determination of appropriate iterative solution differential flux spectra for dissimilar reference neutron environments. These reference spectra, and corresponding measured activities for foils of a single reaction, are used in an inverted iterative process to obtain the evaluated differential cross section curve. Results are presented of the application of this method to the preliminary evaluation of differential cross section data for ^{27}Al(n,α)^{24}Na, ^{58}Ni(n,p)^{58}Co, and ^{54}Fe(n,p)^{54}Mn. (auth)

5859 REVIEW OF SOME FAST NEUTRON CROSS-SECTION DATA. Kanda, Y. (Tokyo Inst. of Tech.); Nakasima, R. pp 193-200 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

Some of the existing cross-section data which are usually adopted as standards in fast neutron experiments are reviewed. The compiled cross-section data are those for ^{27}Al(n,α), ^{56}Fe(n,p), ^{63}Cu(n,2n), and ^{65}Cu(n,2n) reactions in the energy ranging from threshold to 20 MeV. The raw data points are so much scattered that recommendation of the cross section value is difficult to make within the accuracy of 10%. This is mainly due to the ambiguity in determining the flux of neutrons and to the statistical fluctuations in the number of counts. In some cases, the inaccuracy in the neutron energy determination may lead to serious discrepancy. Discussions are presented concerning the activation method and the rejected data. The most probable excitation function is obtained for each reaction by means of the least squares method. (auth)

5860 HELIUM PRODUCTION CROSS-SECTION MEASUREMENTS. Weitman, J.; Daverhoeg, N. (Aktiebolaget Atomenergi, Stockholm). pp 125-37 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

A method suitable for the measurement of reactor spectrum integrated (n,α) cross sections in the sub-millibarn range was developed. The method, which is general insofar as it does not depend on the existence of suitable activities in the product nuclei, relies on the high-vacuum release and mass-spectro-

metric absolute determination of small He quantities, with a minimum detectable limit of 10^{12} He atoms per sample with the present equipment. Initially, the method was tested on boron-loaded, thermal neutron flux-irradiated stainless steel samples, for which the calculated and measured helium amounts could be compared. The first cross-section measurements were performed on nickel, where the dominant $^{58}Ni(n,\alpha)$ reaction produces ^{55}Fe, which only decays by electron capture to the ground state of ^{55}Mn. The nickel samples were irradiated in a boron-shielded rig in a MTR-type reactor to a fast neutron dose of about 10^{20} n/cm^2, the neutron flux being measured by the $^{46}Ti(n,p)^{46}Sc$, $^{58}Ni(n,p)^{58}Co$, and $^{63}Cu(n,\alpha)^{60}Co$ reactions. Considering effects of derivations from a fission flux, a mean fission spectrum integrated He production cross section of nickel of 4.2 mb was obtained, which is much higher than previously assumed in the literature. The measured value is in good agreement with theoretical calculations. The Cranberg spectrum-weighted theoretical excitation function exhibits a maximum around 5 MeV. Some 10%, or 0.5 mb, of the integral $\int^{\infty}\sigma_{n,\alpha}(E)f(E)dE$ falls below 3 MeV and above 7 MeV, respectively. The same method has been used as a very sensitive tool for ^{10}B analysis. In this respect and in ease of interpretation it surpasses the pile oscillator technique. (auth)

5861 IDENTIFICATION OF NEW ARSENIC ISOTOPES IN FISSION: ^{83}As AND ^{84}As. del Marmol, P. (CEN, Mol, Belgium). J. Inorg. Nucl. Chem., 30: 2873-2880(Nov. 1968).

^{83}As and ^{84}As fission products were separated at short time intervals from ^{235}U irradiated with thermal neutrons and were studied by separating and measuring the activities of their bromine granddaughters. ^{83}As has a 14.1 ± 1.1 sec half-life and decays predominantly to 70 sec ^{83m}Se; ^{84}As has a 5.8 ± 0.5 sec half-life. The fractional cumulative yields for thermal fission are 0.80 ± 0.08 for ^{83}As and 0.17 ± 0.02 for ^{84}As. The nuclear charge distribution in this mass region, analyzed in terms of Wahl's empirical Z_p function, shows a fine-structure effect at mass 84. (auth) (UK)

5862 MEASUREMENT OF THE PROBABILITY OF THE EMISSION OF HEAVY CHARGED PARTICLES DURING THE CAPTURE OF μ-MESONS BY NEON NUCLEI. Komarov, V. I.; Savchenko, O. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 415-16(Aug. 1968). (In Russian).

No experimental data are available on the emission probability of charged particles, such as H or He isotopes, during the capture of muons by nuclei with Z > 2. The problem was studied by means of a neon-filled isotropic discharge chamber, exposed to the slow-neutron beam of the JINR synchrocyclotron. The chamber was started up with a delay period of 3.5 μsec after stoppage of the muon; as the storage period amounted to 20 μsec, the track of the stopped muon and the tracks of the secondary particles resulting from either decay or capture of the muon by the neon nucleus were recorded on the same frame. The experimental system made it possible to differentiate between the tracks of heavy charged particles by inspecting the film. Examination of 15,000 frames permitted identification of 1759 events of stoppage of the muons in neon 42 single-ray stars, and 9 stars with larger number of rays. The probability of emitting a heavy particle in a single event of capture of a μ-meson was calculated to be W = 0.20 ± 0.04. This confirmed earlier results which indicated that the value of W during the capture of μ^- mesons by nuclei with Z = 50 is much higher than in the case of capture by nuclei with Z = 35 to 50, in which case W = 0.03. (TTT)

5863 ISOBARIC ANALOG RESONANCES IN $^{66}Zn(p,p')^{66}Zn$ AND $^{68}Zn(p,p')^{68}Zn$ REACTIONS. Gorodetzky, S.; Bergdolt, G.; Bergdolt, A. M. (Centre de Recherches Nucleaires, Strasbourg). J. Phys. (Paris), 29: 722-4(Aug.-Sept. 1968). (In French).

Excitation functions of inelastic scattering for $^{66}Zn(p,p')^{66}Zn^*$ and $^{68}Zn(p,p')^{68}Zn^*$ reactions were measured from 2.8 to 4.2 MeV incident energy. Four isobaric analog resonances were found. The ratios of the inelastic partial widths to the elastic partial widths were determined. (auth)

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Refer also to abstracts 5746, 5765, 5774, 5775, 5786, 5791, 5809, 5813, 5823, 5826, 5828, 5829, 5842–5844, 5849, 5850, 5853, 5854, 5941, and 5944.

5864 (AERE-M-2065(Amend.)) EVALUATION OF THE ^{239}Pu FISSION CROSS SECTION IN THE ENERGY RANGE 1 keV TO 100 keV. James, G. D.; Patrick, B. H. (Atomic Energy Research Establishment, Harwell (England)). Oct. 1968. 8p. (EANDC(UK)-108-AL). Dep. CFSTI. UK 1s. 9d.

Average values of the ^{239}Pu fission cross section in the energy range 1 to 100 keV were determined over 1-keV intervals below 10 keV and 10-keV intervals above 10 keV by means of a least squares analysis of selected data on the ^{239}Pu and ^{235}U fission cross sections and their ratio. The average error in the mean values over these energy intervals is 5.3%. (auth)

5865 (AERE-R-5818) A CATALOGUE OF 30 MeV GAMMA ACTIVATION PRODUCTS. PART 2. RUTHENIUM TO BISMUTH. Baker, C. A.; Wood, D. A. (Atomic Energy Research Establishment, Harwell (England)). July 1968. 53p. Dep. CFSTI. UK 8s. 0d.

The elements from Ru to Bi were irradiated with 30-MeV gamma photons under specified irradiation conditions. Gamma spectra of the active products are presented, together with a value of the specific activity, manner of identification of the nuclides present, and the nuclear reactions by which the products were formed. (auth) (UK)

5866 (BNL-tr-235) CROSS SECTIONS FOR FISSION OF ^{209}Bi, ^{235}U, ^{238}U, ^{237}Np, AND ^{239}Pu BY 1 TO 9-GeV PROTONS. Matusevich, E. S.; Regushevskii, V. I. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Yadern. Fiz., 7: 1187-9(1968). 8p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 46804.

5867 (KURRI-TR-42) THE FAST NEUTRON FLUX MEASUREMENT USING THE $^{103}Rh(n,n')^{103m}Rh$ REACTION. Kimura, Itsuro; Kobayashi, Katsuhei; (and others) (Kyoto Univ. (Japan). Research Reactor Inst.). 1967. 13p. (In Japanese). Dep.

The energy-dependent cross section for the $^{103}Rh(n,n')^{103m}Rh$ was carefully measured. Monoenergetic neutrons were produced with a 2-MeV Van de Graaff accelerator. A thin NaI(Tl) scintillator with a beryllium window was used to measure the relative activity of ^{103m}Rh. For the absolute measurement, a standard ^{103m}Rh source was made from ruthenium trichloride irradiated with thermal neutrons. In this case, the electrodeposition technique was introduced. Although the cross-section curve for the $^{103}Rh(n,n')^{103m}Rh$ reaction shown by Beauge has a resonant peak around 600 keV, the present result shows no peak and seems close to the Vogt and Cross data. And the fission-spectrum-averaged cross section for the reaction was found to be 558 ± 32 mb. The reaction was applied in practice to fast neutron flux measurement at the Kyoto University Reactor. The result agrees closely with the theoretical calculation and shows the effective cross section obtained to be reasonable. Finally, the advantage of using the $^{103}Rh(n,n')^{103m}Rh$ reaction as a fast neutron radiation damage monitor is discussed. (NSA of Japan)

5868 (PUC-937-333) THE NUCLEAR SPINS AND MOMENTS OF ^{119}Sb AND ^{115}Sb. Rogers, Edward H. Jr. (Princeton Univ., N. J. Palmer Physical Lab.). Sept. 1968. Contract AT(30-1)-937. 67p. Dep. CFSTI.

Thesis.

The hyperfine structure (HFS) of 38-hr ^{119}Sb and 31-min ^{115}Sb was measured by the atomic-beam magnetic-resonance method. The isotopes were produced by the $^{119}Sn(p,n)^{119}Sb$ and the $^{116}Sn(p,2n)^{115}Sb$ reactions in the Princeton University cyclotron with isotopically enriched targets. The HFS was studied in the off-line hybrid focusing beam apparatus. The values of the spins, HFS constants, and moments were determined. The least squares fit to the ^{119}Sb data gives $g_J(Sb) = 1.97060(6)$. (auth)

5869 (ZFK-126) INVESTIGATION OF THE LOW-ENERGY LEVEL SCHEME OF ^{110}Ag. Winkler, Peter (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)). June 1967. 25p. (In German). Dep.

The low-lying levels in ^{110}Ag were investigated by measuring γ singles and coincidence spectra from thermal neutron capture by ^{109}Ag. The half-life of the 117.5-keV state was measured to be 33 ± 3 nsec, while the half-lives of the 198.8- and 235.9-keV states were determined to be ≤ 1.5 nsec. (D.C.W.)

5870 LIFE-TIME OF THE LEVEL 242.8 keV IN THE NUCLEUS ^{165}Er. Adylov, G. T.; Babadzhanov, R.; Kuchma, A. S.; Morozov, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 417-23(Sept. 1968). (In Russian).

By means of a multichannel time analyzer with a time–amplitude converter, the lifetime of the 242.8-keV level in the nucleus ^{165}Er was measured from the decay of ^{165}Tm ($T_{\frac{1}{2}}$ = 29 hours). Coincidences of conversion electrons from the 242.8-keV transition with γ rays with energy greater than 1132 keV were analyzed. (auth)

5871 MULTIPLE EXCITATION CORRECTION TO THE COULOMB EXCITATION OF EVEN SPHERICAL NUCLEI. Tamura, T. (Univ. of Texas, Austin). Phys. Lett., 28B: 90-2 (Nov. 11, 1968).

A way to obtain the sign of the static quadrupole moment Q_2 of the first 2^+ state in even spherical nuclei, by considering simul-

taneously Coulomb excitation and (p,p′) processes, is described. (auth)

5872 RELATIVE INTERNAL CONVERSION COEFFICIENTS FOR γ TRANSITIONS OF THE NUCLEUS ^{180}Hf. Gvozdev, V. S.; Grigorev, V. N.; Sergeenkov, Yu. V. (Leningrad Inst. of Physics and Tech.). Yadern. Fiz., 8: 3-6(1968). (In Russian).

Energies and the relative internal conversion coefficients (ICC) for γ transitions of the nucleus ^{180}Hf were measured. The transition with the energy 500.57 keV is shown to be reasonably described by the mixture of the multipolarities: 9 ± 1% M2 and 91 ± 1% E3. For the transition with the energy 57.54 keV, the data obtained confirm the conclusion that the values of ICC for this transition with E1 multipolarity are abnormal and can not be explained by a mixture of other multipolarities with the same parity. For the pure E2 transitions of the rotational band with the energies 93.33, 215.27, 332.26, and 443.09 keV, the relative ICC, measured up to 5 to 10%, do not differ from the theoretical values. (auth)

5873 ^{91}Y AND THE FAILURE OF THE CLOSED SHELL AT ^{88}Sr. Hardy, J. C. (Nuclear Physics Lab., Oxford. Lawrence Radiation Lab., Berkeley, Calif.); Davies, W. G.; Darcey, W. Nucl. Phys., A121: 103-12(1968).

The structure of ^{91}Y was studied using the ^{92}Zr(t,α)^{91}Y and ^{89}Y(t,p)^{91}Y reactions. The fact that the ground states of ^{92}Zr and ^{89}Y have spin-parities of 0$^+$ and $\frac{1}{2}^-$, respectively, made it possible to assign uniquely the spins and parities to nine levels in ^{91}Y for which unambiguous determinations of the transferred angular momenta were obtained in both the (t,α) and (t,p) experiments. A comparison of the experimental results with shell-model calculations in which ^{88}Sr was considered a closed core shows significant disagreement, and it is concluded that there must be appreciable contributions of particle-hole excitations from at least the $(2p_{\frac{1}{2}})$ and $(1f_{\frac{5}{2}})$ shells. (auth)

5874 THE LEVEL STRUCTURE OF ^{210}Bi AND THE REACTION MATRIX THEORY. Nishibori, Yutaka (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 40: 486-98(Sept. 1968).

The low-lying levels of ^{210}Bi are analyzed in detail, by using the j-j coupling odd-group model with the residual Gaussian potential and Brueckner's K matrix. The J dependence of matrix elements is explained in terms of simple kinematical factors. For the K matrix, the values obtained from the BGT and the HJ potentials are examined. It is found that the results with the BGT potential are considerably different from those of the Gaussian potential simulated for the BGT potential by Kim and Rasmussen, deviating from the experimental spectrum, while the results with the HJ potential are in good agreement with the experimental spectrum. With the value of the β-decay parameter, eigenvalues and eigenfunctions are also studied. (auth)

5875 EXPERIMENTAL STUDY AND ANALYSIS OF THE EXCITATION FUNCTIONS ^{165}Ho(α,xn) AND ^{169}Tm(α,xn). Sau, J.; Demeyer, A.; Chery, R. (Univ., Lyon). Nucl. Phys., A121: 131-44(1968). (In French).

Absolute cross sections and excitation functions for α-induced reactions were measured from 15 to 55 MeV by activation and stacked-foil techniques. The following reactions were observed: ^{165}Ho(α,5n)^{164}Tm, ^{165}Ho(α,4n)^{165}Tm, ^{165}Ho(α,3n)^{166}Tm, ^{165}Ho(α,2n)^{167}Tm, ^{165}Ho(α,n)^{168}Tm, ^{169}Tm(α,5n)^{168}Lu, ^{169}Tm(α,4n)^{169}Lu, ^{169}Tm(α,3n)^{170}Lu, ^{169}Tm(α,2n)^{171}Lu and ^{169}Tm(α,n)^{172}Lu. The experimental results agree fairly well with the theoretical value for T = 1.66 MeV except for the high-energy "tail" of these reactions. Interpretations were proposed with the help of a quantal process instead of Monte Carlo calculation (auth)

5876 THE LINEAR POLARIZATION OF THE 279-keV TRANSITION IN ^{203}Tl. Davies, K. E.; Hamilton, W. D. (Univ. of Sussex, Brighton, Eng.). Nucl. Phys., A121: 145-52(1968).

The 279 keV E2-M1 transition in ^{203}Tl is important in nuclear penetration and parity violation experiments. Straightforward γ-γ angular correlation measurements do not provide a method of determining the mixing ratio of this transition accurately. The special methods which have been used to determine the mixing ratio do not give results in complete agreement. A new determination of the magnitude and sign of the mixing ratio has been made by combining results obtained from γ-γ directional and linear polarization correlation experiments. The result obtained $\delta(279) \leq 1.1$, is in agreement with the presently accepted value. In addition, the spin of the 680 keV level in ^{203}Tl has been shown explicitly to be $\frac{5}{2}$ as is commonly assumed. (auth)

5877 THE SINGLE-PARTICLE E1 TRANSITIONS WITH ΔK = 1 IN DEFORMED NUCLEI. Feifrlik, V.; Rizek, J. (Inst. of Nuclear Research, Rez, Czech.). Nucl. Phys., A121: 153-60(1968).

The absolute intensities of anomalous E1 (ΔK = 1) transitions between intrinsic states of deformed odd-mass nuclei in the rare earth region were calculated in the framework of Migdal's finite Fermi-system theory and compared with all available experimentally determined data. The single-particle transitions in 22 nuclei were satisfactorily explained using three parameters determining the interaction between quasi-particles. (auth)

5878 THE DECAY OF ^{146}Eu. Paperiello, C. J.; Buss, D. J.; Funk, E. G.; Mihelich, J. W. (Univ. of Notre Dame, Ind.). Nucl. Phys., A121: 191-208(1968).

The decay of ^{146}Eu, in equilibrium with ^{146}Gd, to excited states in ^{146}Sm was studied with a Ge(Li) detector and a scintillation detector in singles and in coincidence. Gamma-ray energies and relative intensities were obtained from the analysis of Ge(Li) singles spectra. The spectra of gamma rays in coincidence with the 633–634 keV composite transition and the 747.1 keV transition were obtained. Internal conversion coefficients were obtained by comparing the gamma-ray intensities with available internal conversion electron intensities. In addition to the well-known states at 747.1 keV (2$^+$), 1380.5 keV (3$^-$) and 1381.3 keV (4$^+$), levels for which tentative spin and parity assignments may be made are those at (energies in keV) 1648.3 (2$^+$), 1811.6 (2 through 6$^+$, 1 through 5$^-$), 2046 (2, 3, 4$^-$), 2083.1 (2, 3, 4$^+$), 2103.5 (1, 2$^+$), 2155.9 (2$^+$), 2192.7 (2, 3$^+$), 2269.9 (3, 4$^+$), 2280.9 (2, 3$^+$), 2438.9 (2, 3, 4$^+$), 2497.6 (2$^+$), 2513.5 (2, 3$^-$), 2532.0 (3, 4, 5$^+$), and 2678.3 (4, 5$^+$). A number of additional levels up to 3546 keV are included in a proposed level scheme. (auth)

5879 THE SINGLE-HOLE STATES IN THE 50 < N ≦ 126 SHELL WITH (p,d) REACTIONS. Yagi, K.; Ishimatsu, T.; Ishizaki, Y.; Saji, Y. (Tokyo Univ.). Nucl. Phys., A121: 161-75(1968).

The neutron single-hole states in the 50 < N ≦ 82 shell were studied by the ^{140}Ce(p,d) reaction at 55 MeV incident energy, and those in the 82 < N ≦ 126 shell by ^{208,206}Pb(p,d) reactions. Emitted deuterons were analyzed with a broad-range magnetic spectrometer. Angular distributions were analyzed in terms of the DWBA method. The l-values for all deuteron groups were assigned, and the j$^\pi$ value and the spectroscopic factor for each state were obtained. The single-hole energies in $^{141}_{59}$Ce$_{81}$ obtained were $d_{\frac{5}{2}}$ − 0; $s_{\frac{1}{2}}$ −0.25; $h_{\frac{11}{2}}$−0.75; $d_{\frac{3}{2}}$−1.58; $g_{\frac{7}{2}}$−2.81 MeV (in excitation energies). These results are much different from those of the Pittsburgh group with the (d,t) reactions. The new result that the $g_{\frac{7}{2}}$ state jumps below the $d_{\frac{3}{2}}$ state is interpreted by considering the interaction between the $g_{\frac{7}{2}}$ neutrons and the last eight protons in the $g_{\frac{9}{2}}$ orbit of ^{138}Ce. The single-hole energies in $^{207}_{82}$Pb$_{125}$ are: $p_{\frac{1}{2}}$−0; $f_{\frac{5}{2}}$−0.57; $p_{\frac{3}{2}}$−0.90; $i_{\frac{13}{2}}$−1.63; $f_{\frac{7}{2}}$−2.34; $h_{\frac{9}{2}}$ −3.41 MeV. The correspondence of the states in ^{205}Pb with those in ^{207}Pb was obtained from the angular distribution analysis. No evidence was found for the J-dependence of angular distributions in either the l = 3 or l = 1 Pb(p,d) transitions. The Q-dependence is discussed. (auth)

5880 STUDY OF THE RADIATIVE CAPTURE OF RESONANCE NEUTRONS IN PLATINUM. Samour, C.; Jackson, H. E.; Julien, J.; Bloch, A.; Lopata, C.; Morgenstern, J. (CEN, Saclay, France). Nucl. Phys., A121: 65-96(1968). (In French).

The statistical properties of the partial radiative widths in ^{196}Pt were studied with the Saclay linear accelerator using the time-of-flight method and a Ge(Li) detector. The spectra for 22 resonances with spin and parity 1$^-$ were analyzed, and a sample of 66 transitions was obtained. The result of such a study confirms the validity of the Porter-Thomas distribution for these widths; the data agree with a χ^2-distribution with one degree of freedom and are clearly inconsistent with the exponential law. Several statistical analysis methods were used. From the number of 1$^-$ resonances, it is possible to calculate the average relative intensity of some transitions and to compare them with values calculated from theoretical estimates. In addition, a new level scheme of doubly even ^{196}Pt nuclei was obtained and compared with previous results and theoretical predictions; 40 levels were found. This scheme is confirmed by thermal neutron capture and by ^{196}Au radioactive decay. A partial scheme is obtained for some odd isotopes of platinum (^{193}Pt, ^{197}Pt and ^{199}Pt). (auth)

5881 TOTAL CROSS SECTION OF CADMIUM FOR NEUTRONS OF ENERGY BETWEEN 0.01 AND 10 eV. Widder, F.; Brunner, J. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Nukleonik, 11: 297-8(Oct, 1968).

The neutron total cross section of Cd was measured in the energy range from 0.01 to 10 eV using a slow chopper facility. A value of 2455 ± 10 barns was obtained for the total cross section at 0.0253 eV. Resonance parameters were determined for the 0.178-eV resonance of ^{113}Cd. (D.C.W.)

5882 ON THE FORM FACTOR IN INELASTIC DEUTERON SCATTERING. Bang, J. M.; Saethre, Oe. (Univ., Copenhagen). Phys. Lett., 28B: 99-101(Nov. 11, 1968).

Effects of the finite size of the deuteron and the diffuseness of the target charge density on the coupling potentials in inelastic deuteron scattering are calculated. (auth)

5883 MEASUREMENT OF RELATIVE PROBABILITY OF TERNARY FISSION OF ^{233}U, ^{235}U, ^{238}U, AND ^{232}Th. Nad, L.;

Nad, T.; Vinnai, I. (Budapest Central Research Inst. of Physics). Yadern Fiz., 8: 443-7(Sept. 1968). (In Russian).

The relative probability of long-range α-particle production in the fission of ^{233}U, ^{235}U, ^{238}U, and ^{232}Th by slow neutrons and by neutrons with energies of 2.5 and 14 MeV was measured by means of a double ionization chamber. At different energies of neutrons initiating the fission, relative probabilities of ternary fission of ^{235}U within experimental error were found to be equal. The same result was obtained for ^{232}Th. The probability of α-particle emission in the fission of ^{238}U by 14-MeV neutrons proved to be higher than in the fission by 2.5-MeV neutrons. It was also shown that the probability of ternary fission increases with the increase of the ratio Z^2/A. (auth)

5884 ENERGY DISTRIBUTION OF α PARTICLES PRODUCED IN THERMAL-NEUTRON FISSION OF ^{241}Pu AND ^{241}Am. Solov'eva, Z. I. Yadern. Fiz., 8: 454-8(Sept. 1968). (In Russian).

Energy spectra of long-range α particles produced by thermal-neutron fission of ^{241}Pu and ^{241}Am were investigated by means of nuclear emulsions (type P-9-0). The spectra obtained are approximated by the Gaussian distribution with the parameters: E_{max} = 15.0 ± 0.6 MeV, ΔE = 8.3 ± 0.5 MeV (^{241}Pu); E_{max} = 15.8 ± 1.2 MeV, and ΔE = 11.2 ± 0.9 MeV (^{241}Am). The results are compared with energy spectra of α particles produced by fission of other isotopes. (auth)

5885 NOTE ON K-SHELL INTERNAL CONVERSION COEFFICIENT OF THE 279 keV TRANSITION IN ^{203}Tl. Rajput, M. S. (Aligarh Muslim Univ., India). Curr. Sci. (India), 37: 39-40 (Nov. 20, 1968).

The K-shell internal conversion coefficient for the 279-keV transition in ^{203}Tl was remeasured using a scintillation spectrometer in order to estimate the nuclear penetration effects. (D.C.W.)

5886 OBSERVATION OF Po AND At ISOTOPES AMONG FRAGMENTS FROM FISSION OF ^{238}U BOMBARDED BY IONS ^{20}Ne AND ^{40}Ar. Kuznetsov, I. V.; Mal'tseva, N. S.; Oganesyan, Yu. Ts.; Sukhov, A. M.; Shchegolev, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 448-53(Sept. 1968). (In Russian).

Yields of $^{204,206,208,210}Po$ and $^{207,209,211}At$ in fragments from fission of ^{238}U bombarded by the ions of ^{20}Ne and ^{40}Ar were measured. Control experiments were carried out to exclude the possible production of the isotopes in stripping reactions. Data on production of the isomeric states ^{211m}Po and ^{212m}Po in the fragments are presented. The experimental results are discussed in view of the cascade fission. The possibility of synthesis of isotopes in fission reactions is indicated. (auth)

5887 INVESTIGATION OF (d,p) AND (d,t) REACTIONS WITH PRODUCTION OF SPONTANEOUSLY FISSIONABLE ISOMERIC STATES. B'ernkhol'm, S.; Borggrin, I.; Gangrskii, Yu. P.; Sletten, G. (Joint Inst. for Nuclear Research, Dubna, USSR. Univ. of Copenhagen). Yadern. Fiz., 8: 459-62(Sept. 1968). (In Russian).

The (d,p) and (d,t) reactions with production of spontaneously fissionable isomeric states $^{240,242,244}Am$ were investigated in the deuteron energy range from 9 to 13 MeV. Measurements of the (d,p) and (d,t) reaction cross sections indicate that the isomeric ratio for these reactions is essentially less that for the (d,2n) reactions with production of the same nuclei. The difference in the isomeric ratios can not be due to the difference in the excitation-energy distributions and in the spins of the nuclei that remain after the particles are emitted. The results obtained are discussed on basis of the hypothesis of the shape isomerism. (auth)

5888 g-FACTORS AND MIXING RATIOS IN ^{156}Gd. Weitsch, A.; Walter, H. K. (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 216: 459-71(1968). (In German).

By the method of integral perturbed γ-γ-angular correlation, the gyromagnetic ratios of a 2-quasiparticle state at 1,513 keV and the 4^+ state of the ground-state rotational band in ^{156}Gd were measured, using sources prepared by $^{159}Tb(\gamma,3n)$ and $^{156}Gd(d,2n)$ reactions. The multipole mixing ratios for the 535- and 1,225-keV γ rays were obtained. The classification of the 1,513-keV state is discussed. The internal field of Gd in Tb metal at 77°K was found to be H = −192 ± 16 kOe. (auth)

5889 DETECTION OF A SPIN DEPENDENT EFFECT IN THE GAMMA SPECTRUM FOLLOWING NEUTRON CAPTURE. Coceva, C.; Corvi, F.; Giacobbe, P.; Carraro, G. (EURATOM, Geel, Belgium. CNEN, Bologna). pp 897-902 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

The dependence of gamma cascades on the spin of the initial state is exploited to determine the spin of the levels excited by s-wave neutron interaction. The method, based on simultaneous detection of single and coincidence counts by two NaI(Tl) crystals, puts into evidence differences in the general characteristics of gamma cascades such as multiplicity and spectrum shape. The validity of the method is supported by the results of a numerical simulation of the gamma decay process. Results are given for the isotopes: ^{96}Mo, ^{97}Mo, ^{99}Ru, ^{101}Ru, ^{105}Pd, and ^{177}Hf. (auth)

5890 CALCULATIONS OF ELASTIC SCATTERING AND INELASTIC DIRECT PROCESSES OF FAST NEUTRONS BY ^{238}U. Buehler, F. (Univ., Stuttgart). pp 933-41 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

Elastic scattering and inelastic direct processes of fast neutrons by ^{238}U were studied in the energy range 2.5 to 14.1 MeV using coupled-equations methods. The target nucleus is described by the collective model. The whole interaction to which the incident neutron is subjected is described by a nonspherical optical-model potential with a spherical spin-orbit coupling. To overcome the difficulties in fitting the parameters of the optical model, the nuclear form factors are determined by generalizing the equivalent local potential of Perey and Buck. Over the whole energy range a good agreement between theoretical and experimental elastic cross sections is found. The same deformation parameter of the interaction potential was used for all projectile energies. It was compared with the reduced transition probability of Coulomb excitation. The influence of higher rotational states of ^{238}U on the elastic and inelastic direct scattering was studied. In case of inelastic scattering, the often-used hypothesis that only ground state and first excited state are strongly coupled is found to be not valid. The influence of the 4^+ and 6^+ states on the potential elastic scattering is unimportant. (auth)

5891 EVALUATION OF ^{238}U NEUTRON DATA IN THE ENERGY RANGE .0001 eV TO 15 MeV. Vastel, M. (Electricite de France, Paris); Ravier, J. pp 1129-41 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

A complete set of neutron cross sections and related quantities was re-evaluated up to the beginning of 1967 in order to revise the evaluation on ^{238}U included in 1963 in the United Kingdom Nuclear Data Library. The evaluated parameters were used in the Breit-Wigner theory in order to calculate the cross sections in the resolved resonances energy range which was extended up to 3.6 keV. Above 10 keV, this evaluation is mainly characterized by a better determination of the differential elastic scattering up to 1 MeV, an appreciable change in the inelastic cross section in the energy range 0.2 to 0.8 MeV and of the fission cross section between 2 and 4 MeV. No definitive conclusions could be obtained for the capture cross section, because of inconsistencies in both the experimental and theoretical values. A comparison made with evaluations of ^{238}U data from the KEDAK and ENDF/B Libraries did not reveal large differences but some requests of fast reactor physicists given in the EANDC request list have not been satisfied. (auth)

5892 A COMPARISON OF ^{240}Pu CROSS-SECTION EVALUATIONS BY CALCULATIONS OF ZPR-III ASSEMBLIES 48 AND 48B. Pitterle, T. A.; Yamamoto, M. (Atomic Power Development Associates, Inc., Detroit). Contract AT(11-1)-865. pp 1253-61 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

Uncertainties in ^{240}Pu cross sections have an important influence on fast reactor parameters such as the sodium void and Doppler coefficients, breeding ratio, etc. Recent evaluations are compared, in particular, two evaluations of the present authors differing primarily by the assumed value of the radiative width. One evaluation is the ENDF/B data which is based on Γ_γ = 30 mV from the measurements of Bockhoff and Byers while the other evaluation utilizes Γ_γ = 20 mV from the measurements of Asghar. To assist in evaluating the accuracy of the ^{240}Pu cross-section data, calculations were made for ZPR-III Assemblies 48 and 48B using both the ENDF/B data file and a modified ENDF/B data file for the critical assembly calculations. The experimental and cal-

culated results are compared to assess the importance of the ^{240}Pu cross-section uncertainties. (auth)

5893 A MATHEMATICAL SCHEME FOR EVALUATING CROSS-SECTION DATA ON THE FISSILE ISOTOPES ^{233}U, ^{235}U, AND ^{239}Pu IN THE ENERGY RANGE 10 keV TO 10 MeV. Young, P. C.; Cady, K. B. (Cornell Univ., Ithaca, N. Y.). pp 1109-16 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

A mathematical scheme for evaluating simultaneously the experimental data on the three fissile isotopes is being investigated by means of an energy-dependent, correlated, nonlinear least squares analysis. The scheme correlates the experimental data available for each isotope with the data available as ratio measurements between the isotopes, and incorporates an internal normalizing procedure for data available as relative measurements. The independent quantities (e.g., σ_f, α, ν) for each isotope are described by energy-dependent analytic functions; and from these, the dependent quantities for each isotope (e.g., σ_γ, η, σ_a) and the ratios of quantities between isotopes (e.g., $\sigma_f\,^{233}U/\sigma_f\,^{235}U$, $\sigma_f\,^{239}Pu/\sigma_f\,^{235}U$ can be generated. Where relative quantities were experimentally measured, the unnormalized data will be used as the input to the scheme; normalizing values will be obtained internally as part of the evaluating procedure. The weight (a measure of the reliability) assigned to each data point will be determined by the quoted standard deviation, augmented, as warranted, by an examination of the individual experiments in regard to the techniques employed and to assumptions applied which may no longer be valid. It is anticipated that a large part of the discrepancy in the experimental data that is now in evidence may be eliminated by the use of the common normalizing values generated by the scheme. (auth)

5894 MEASUREMENTS OF ABSORPTION RESONANCE INTEGRALS FOR ^{176}Hf, ^{177}Hf, ^{178}Hf, ^{179}Hf, AND ^{180}Hf. Fulmer, R. H.; Esch, L. J.; Feiner, F.; Ruane, T. F. (Knolls Atomic Power Lab., Schenectady, N. Y.). pp 821-5 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

Absorption resonance integrals were determined for the major Hf isotopes by pile oscillator measurements in the KAPL Thermal Test Reactor. The samples were isotopically enriched HfO_2 diluted in Al_2O_3 ceramic pellets. Corrections for self-shielding in the more strongly absorbing samples were made by extrapolating the results of samples with varying dilution to infinite dilution. Measurements were calibrated with gold samples. The Au resonance integral was taken as 1558 b at a Cd cutoff energy of 0.5 eV. Corrections to the data for variations in Cd cutoff and deviations in the neutron spectrum from 1/E were made. After these corrections, the resonance integrals are ^{176}Hf, 640 ± 30 b; ^{177}Hf, 7380 ± 500 b; ^{178}Hf, 1950 ± 120 b; ^{179}Hf, 660 ± 30 b; and ^{180}Hf, 43 ± 8 b. From these values, the synthesized resonance integral for natural hafnium is 2040 b, in good agreement with a recent measurement of 2125 ± 50 b. These preliminary results may also be compared with values computed from differential measurements with allowance for unresolved resonances. The computed values are ^{176}Hf, 339 b; ^{177}Hf, 7192 b; ^{178}Hf, 1883 b; ^{179}Hf, 497 b; and ^{180}Hf, 36 b. (auth)

5895 CROSS-SECTION MEASUREMENTS FOR THE REACTION $^{152}Eu(n,\gamma)^{152m}Eu$ BETWEEN 0.02 eV AND 0.5 eV. Poortmans, F.; Fabry, A.; Girlea, I. (SCK-CEN, Mol, Belgium). pp 883-4 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

The activation method was used to measure the cross section for the reaction $^{151}Eu(n,\gamma)^{152m}Eu$ between 0.02 and 0.5 eV. These data are important as ^{151}Eu is used as an activation detector for spectral index measurements in reactors. Monochromatic neutrons were produced with the BR2 crystal spectrometer. Data are given for several neutron energies below 0.5 eV. Isomeric ratios for the resonances at 0.3210 and 0.460 eV are deduced. (auth)

5896 TOTAL NEUTRON CROSS SECTION OF ^{204}Tl FROM 0.2 eV TO 1000 eV. Watanabe, T.; Stokes, G. E.; Schuman, R. P. (Idaho Nuclear Corp., Idaho Falls). pp 893-6 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

The neutron total cross section of ^{204}Tl was measured from 0.2 to 1000 eV. The sample was produced by irradiating natural thallium in the Engineering Test Reactor (ETR). The transmission data are analyzed using the area method to obtain resonance parameters for the two resonances observed at 122 and 796 eV. Problems associated with taking cross section measurements of a sample produced by neutron irradiation and unseparated from the feed material are discussed. (auth)

5897 NUCLEAR LEVEL SCHEMES FROM RESONANCE NEUTRON CAPTURE (^{196}Pt, ^{184}W, ^{200}Hg, ^{64}Cu, ^{66}Cu, ^{36}Cl, ^{198}Au, ^{60}Co). Alves, R. N.; Samour, C.; Kuchly, J. M.; Julien, J.; Morgenstern, J. (CEN de Saclay, Gif-sur-Yvette, France). pp 783-7 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

Gamma spectra from resonance neutron capture by ^{35}Cl, ^{63}Cu, ^{65}Cu, ^{197}Au, ^{199}Hg, ^{196}Pt, and ^{183}W were measured; and states were identified in the product nuclei. Spin-parity assignments were made for many of the states observed. (D.C.W.)

5898 NEUTRON RESONANCE PARAMETERS OF CADMIUM AND ANTIMONY. Asami, A.; Okubo, M.; Nakajima, Y.; Fuketa, T. (Japan Atomic Energy Research Inst., Tokai). pp 789-94 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

Transmission measurements on the natural elements of Cd and Sb were carried out with the neutron time-of-flight spectrometer at the JAERI Linac. Metallic samples of different thicknesses, from 0.0047 to 0.306 atoms/barns for Cd and from 0.00085 to 0.183 atoms/barn for Sb, were used. The neutron energy region from a few eV up to several keV was covered with maximum resolution of 10 nsec/m. Transmission measurements with samples at liquid-nitrogen temperature were also made to improve separation of closely spacing resonances. New resonances at relatively low energies were found at 54.3, 59.8 and 62.3 eV in Cd and at 37.9 and 55.2 eV in Sb. The resonance dips in the transmission data are analyzed by the area-analysis method based on the Breit-Wigner single-level formula. The values of the neutron widths and the total widths will be tabulated. (auth)

5899 NEUTRON CAPTURE RESONANCES OF TUNGSTEN IN THE RANGE 150 eV TO 100 keV. Bartolome, Z. M.; Moyer, W. R.; Hockenbury, R. W.; Tatarczuk, J. R.; Block, R. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. pp 795-801 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

Experimental data on neutron capture in metallic samples of ^{182}W, ^{183}W, ^{184}W, and ^{186}W, were taken with the 1.25-diameter capture tank and a time-of-flight resolution of 2 nsec/meter. Preliminary analysis show that, compared with previous results, at least 9 new prominent resonances are observed in the energy range 225 eV to 4 keV for ^{182}W, 36 new resonances observed in the range 180 eV to 2.6 keV for ^{183}W, 12 observed in the range 145 to 4 keV for ^{184}W, and 8 observed in the range 350 eV to 4 keV for ^{186}W. In addition, previously reported single resonances were resolved in doublets; these are at 3434 and 4005 eV in ^{182}W and at 1012, 1402, and 1698 eV in ^{183}W. Cursory examination of the new data indicates the possibility of analyzing resonances up to approximately 20 keV. The data are in the process of being reduced to yields and Monte Carlo corrections are being applied through the use of the direct link between the NYU CDC-6600 computer and the RPI IBM-1130 computer. (auth)

5900 NEUTRON SCATTERING MEASUREMENTS IN LOW-ENERGY Cd AND Rh RESONANCES. King, T. J.; Block, R. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. pp 735-41 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

Scattering measurements were made using two ^6Li glass scintillators as neutron detectors together with a large liquid scintillator anticoincidence mantle. This system provides high neutron efficiency, fast timing for time-of-flight spectrometry, and greater

than 90% rejection of capture background in the ^{6}Li glasses. The high rejection of capture background comes about because of the high efficiency (>90%) for the detection of neutron capture by the large liquid scintillator. This rejection results in an extremely small capture background in the glasses. Measurements were carried out on Rh and Cd from 30 to 1500 eV, and six resonances were analyzed for resonance parameters in Rh. These results, together with the results of transmission measurements (which were also made for these samples), yield the spin (J), neutron width (Γ_n) and the total width (Γ) for each resonance. (auth)

5901 A STUDY OF PARTIAL RADIATIVE WIDTHS AT AND BETWEEN NEUTRON RESONANCES. Samour, C. (CEN de Saclay, Gif-sur-Yvette, France); Alves, R.; Jackson, H. E.; Julien, J.; Morgenstern, J. pp 669-73 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

Resonance neutron capture γ spectra were measured using an 8-cc Ge(Li) detector in time-of-flight experiments with flight paths of 14.7 and 28.7 m. A two-parameter tape recording system was used to record the spectra. The distribution of partial radiative widths was determined in the framework of the Porter-Thomas formalism. The possibility of correlation between two partial radiative widths relative to transitions going to very close energy states was investigated, considering the two dipole electric transitions to the ground state and the first excited state of ^{184}W. It was concluded that there is no correlation between these two transitions. Interference effects between resonances in ^{197}Au and ^{195}Pt were observed. A direct capture cross section of 10 ± 2 mb was required to fit data on the 7490-keV transition in ^{59}Co + n. Experimental reduced widths were calculated for a number of transitions using Bartholomew's formalism; the results were compared with Blatt-Weisskopf estimates. (D.C.W.)

5902 TOTAL NEUTRON CROSS SECTION AND RESONANCE PARAMETERS FOR ^{147}Pm. Kirouac, G. J.; Eiland, H. M.; Slovacek, R. E.; Conrad, C. A.; Seemann, K. W. (Knolls Atomic Power Lab., Schenectady, N. Y.). Contract W-31-109-eng-52. pp 687-94 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968. (KAPL-P-3402).

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

The total cross section of ^{147}Pm was determined by transmission measurements on four $^{147}Pm_2O_3$ samples over the energy interval 0.008 to 200 eV. The samples contained about 1.6% of the decay product ^{147}Sm. The experimental resolution varied from 0.10 μ sec/m at 1.5 eV to about 0.05 μ sec/m at 200 eV. The methods of shape and area analysis were used to obtain the resonance parameters. From these parameters, the following data are derived: an s-wave level spacing 6.8 ± 1.5 eV, and average s-wave strength function of $3.1 \pm 0.8 \times 10^{-4}$, and a capture resonance integral of 2300 ± 260 barns. (auth)

5903 DECAY OF ^{145}Eu TO LEVELS IN ^{145}Sm. Adam, I. (Univ. of Copenhagen); Toth, K. S.; Roche, M. F. Nucl. Phys., A121: 289-305(1968).

The decay of ^{145}Eu to levels in ^{145}Sm was investigated. Singles γ-ray spectra were obtained with the use of Ge(Li) detectors, and $\beta^+-\gamma$ (NaI) and e-γ (NaI) coincidence measurements were performed. By intercomparison of the photon intensity data with published conversion-electron intensity data, K-shell internal-conversion coefficients were calculated for most of the transitions observed in the γ-ray spectra. From the $\beta^+-\gamma$ coincidence measurements, the ^{145}Eu decay energy was found to be 2710 ± 15 keV. A level scheme with 23 excited states in ^{145}Sm was proposed based on results obtained from e-γ coincidence measurements, on transition energies, intensities and multipole orders, on the measured decay energy and on data available from (d, p) reaction studies. Energies (in keV) and spin and parity assignments (enclosed in parentheses) for the proposed levels in ^{145}Sm are as follows: 0($^{7}/_{2}^{-}$), 894.1($^{3}/_{2}^{-}$), 1423($^{3}/_{2}^{-}$), 1437($^{1}/_{2}$, $^{3}/_{2}$, $^{5}/_{2}^{+}$), 1548($^{3}/_{2}^{+}$), 1628($^{+}$), 1658($^{3}/_{2}$, $^{5}/_{2}^{-}$), 1805($^{+}$), 1859($^{1}/_{2}$, $^{3}/_{2}^{-}$), 1877($^{5}/_{2}$, $^{7}/_{2}^{-}$), 1972($^{3}/_{2}^{-}$), 1997($^{5}/_{2}$, $^{7}/_{2}^{-}$), 2111, 2134($^{3}/_{2}$, $^{5}/_{2}$, $^{7}/_{2}^{-}$), 2156($^{1}/_{2}^{-}$), 2193, 2276, 2293(≦ $^{7}/_{2}^{-}$), 2329, 2346, 2388, 2427(≦ $^{7}/_{2}^{-}$), 2482 and 2510. The (K-capture/β^+) ratio for the first-forbidden transition that populates the 894.1-keV state was measured to be 80(±50%) as compared to the theoretical ratio of 42 for an allowed transition. By the use of closed energy cycles and the measured ^{145}Eu decay energy, the electron-capture decay energies for ^{153}Ho and ^{149}Tb are predicted to be 4.22 ± 0.06 and 3.69 ± 0.03 MeV, respectively. (auth)

5904 CALCULATION OF ROTATIONAL ENERGIES IN RARE-EARTH NUCLEI. Krumlinde, J. (NORDITA, Copenhagen). Nucl. Phys., A121: 306-28(1968).

A simple model for calculating nuclear rotational energies is derived, taking into account the effects of Coriolis decoupling of the pair field and of centrifugal stretching. Comparison with experimental values is included. (auth)

5905 DIRECT NEUTRON CAPTURE IN LEAD. Broomhall, G. J. (Univ. of Melbourne); Bird, J. R. Nucl. Phys., A121: 329-36(1968).

Data for neutron capture and photonuclear reactions in lead isotopes were re-analyzed and show consistent evidence for an asymmetry in the 43-keV resonance in ^{207}Pb(n,γ). Interpretation of the asymmetry is complicated by the presence of small p-wave resonances, but it can be explained by assuming a direct capture cross section of 0.04 b at 1 eV. (auth)

5906 ANALYSIS OF THE $\beta 1^- \rightarrow 2^+$ TRANSITIONS OF ^{186}Re AND ^{188}Re. Andre, S.; Liaud, P. (CEN, Grenoble, France). Nucl. Phys., A121: 337-49(1968).

The β spectra of the $1^- \rightarrow 2^+$ transitions leading to the first excited states of ^{186}Os and ^{188}Os were measured. With these results and other available experimental data the four nuclear matrix elements were determined; $\int i\alpha$ and $\int r$ were taken as independent parameters to test the theoretical ratio $\Lambda = \int i\alpha / \xi \int r$. Results show that Fujita's calculation is not verified; the Nilsson model gives good agreement with $\Lambda\xi = (N_i - N_f)\hbar\omega_0$. Values of the nuclear matrix elements from a single-particle Nilsson wave function calculation are in qualitative agreement with experiment. (auth)

5907 THE LEVEL STRUCTURE OF ^{193}Ir. Plajner, Z.; Brabec, V.; Maly, L.; Vejs, M. (Nuclear Research Inst., Rez, Czech.). Nucl. Phys., A121: 367-79(1968).

The decay of ^{193}Os was studied with a 30-cm double-focusing β spectrometer, intermediate-image β spectrometer, lithium-drifted germanium detectors, and β-γ and γ-γ coincidence techniques. Of 27 observed transitions, the 41.0, 65.9, 96.1, and 185.5 keV transitions were established for the first time; the 41.0 and 65.9 keV transitions were determined from coincidence information only. Internal conversion, gamma-ray and gamma-gamma coincidence intensities are given. The multipolarities of some transitions were derived from relative internal conversion electron intensity ratios or K-internal conversion coefficients. The present data are consistent with a proposed decay scheme with excited states at 73.05, 138.95, 179.9, 362.3, 440.8, 460.8, 557.6, 559.5, 659.6, and 712 keV. An attempt was made to interpret some levels of the proposed decay scheme. (auth)

5908 ASYMMETRY IN ANGULAR DISTRIBUTIONS OF PHOTONEUTRONS. Lepestkin, A. I. (Saratov State Univ., USSR). Yadern. Fiz., 8: 433-8(Sept. 1968). (In Russian).

Angular and energy distributions of photoneutrons from Bi were measured at $E_{\gamma max}$ = 20 MeV. The neutrons were detected by means of recoil protons in nuclear emulsions. As a result the data were obtained for various intervals of the energy E_n. Special attention was given to obtaining data in the energy region $E_n \geq 5$ MeV. The present results are compared with other data obtained by various methods at various maximal energies of the γ quanta spectrum. The results obtained indicate an increase of the anisotropy with the neutron energy. The asymmetry observed by some authors at the energy $E_{\gamma max} \approx 20$ MeV is not confirmed by the present work. (auth)

5909 ON THE ANOMALOUS FORWARD SCATTERING OF NEUTRONS WITH ENERGY 14 MeV ON URANIUM. Adam, A.; Deak, F.; Jeki, L.; Kiss, A.; Koevessy, Z.; Palla, G.; Hrasko, P. (Budapest Central Research Inst. of Physics). Yadern. Fiz., 8: 439-42(Sept. 1968). (In Russian).

Differential cross sections for elastic scattering of 14.7-MeV neutrons were measured. The analysis of the scattering data in terms of the optical model does not show the occurrence of any anomaly. (auth)

5910 THE DECAY OF THE 11.80 MeV ISOBARIC ANALOG RESONANCE IN ^{93}Tc TO NEGATIVE PARITY STATE IN ^{92}Mo. Lieb, K. P.; Hausmann, T.; Kent, J. J.; Moore, C. F. (Univ. of Texas, Austin). Z. Phys., 217: 213-24(1968).

The 2,524-keV 5^- state and 2,848-keV 3^- state in ^{92}Mo were excited by inelastic proton scattering going through the 11.80-MeV isobaric analog resonance in ^{93}Tc. Angular distributions of the $3^- \rightarrow 2^+$ and $5^- \rightarrow 4^+$ γ-rays were measured and were analyzed in order to obtain the partial waves of the outgoing protons. (auth)

5911 THE DECAY OF ^{125m}Xe, ^{127m}Xe, AND ^{129m}Xe. Schmidt-Ott, W.-D.; Weirauch, W.; Smend, F.; Langhoff, H.; Gfoeller, D.

(Univ., Goettingen, Ger.). Z. Phys., 217: 282-93(1968). (In German).

The decay of ^{125m}Xe produced by the reaction ^{122}Te(α,n)^{125m}Xe using a target enriched in ^{122}Te(95.4%) and the decay of ^{127m}Xe produced by the reaction ^{127}I(d,2n)^{127m}Xe were investigated. ^{125m}Xe decays with a half-life of $T_{\frac{1}{2}}$ = 56 ± 3 sec by a $\gamma\gamma$-cascade with $E_{\gamma 1}$ = 140.4 ± 0.5 keV and $E_{\gamma 2}$ = 110.5 ± 0.5 keV. The experimental conversion coefficients yield multipolarities of E3 for the 140.4-keV isomeric transition and predominantly M1 for the 110.5-keV transition. ^{127m}Xe decays with a half-life of $T_{\frac{1}{2}}$ = 71 ± 2 sec. The decay also proceeds by a γ-γ cascade with an isomeric E3 transition of $E_{\gamma 1}$ = 172.5 ± 0.3 keV and a predominantly M1 transition of $E_{\gamma 2}$ = 124.6 ± 0.3 keV. In the decay of ^{127g}Xe, an additional branching of the electron capture to a level at 618.1 ± 0.3 keV was observed. The relative probability for K-capture P_{K618}/P_{K375} = 0.40 ± 0.07 yields a total transition energy Q_{EC} = 664 ± 4 keV. A spin of $\frac{1}{2}^+$ was assigned to the ground state. (auth)

5912 MEASUREMENT OF GAMMA-RAY PRODUCTION CROSS SECTIONS USING A LINAC. Orphan, V. J.; Carlson, A. D.; Hoot, C. G. (Gulf General Atomic, Inc., San Diego, Calif.). pp 139-52 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

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A newly constructed facility which was designed especially for the measurement of gamma-ray production cross sections using a pulsed LINAC neutron source is currently being operated at Gulf General Atomic. The initial program for this facility is concerned with the measurement of epithermal capture gamma-ray spectra and yields for W, and the measurement of gamma-ray production cross sections by inelastic scattering in O and N. Later phases of the work will extend the capture gamma-ray spectra to ^{238}U, Zr, and Fe, and the inelastic production to W and Fe. Large volume Ge(Li) detectors have been developed and are being used in these studies. In the case of capture gamma-ray work, a gamma-ray spectrometer will be used which consists of a large Ge(Li) detector located inside a split NaI annulus. This system can be used in the pair spectrometer mode at high gamma-ray energies and in the Compton suppression mode at low gamma-ray energies. The principal considerations involved in using a LINAC for these measurements are discussed together with the necessary extensions of previously used techniques. The experimental results obtained in the initial phase of the program are presented. (auth)

5913 PHOTONEUTRON CROSS SECTIONS OF La, Tb, Ho, AND Ta. Bergere, R.; Beil, H.; Veyssiere, A. (CEN, Saclay, France). Nucl. Phys., A121: 463-80(1968).

Partial photoneutron cross sections (γ,n), (γ,2n) and (γ,3n) of ^{139}La, ^{159}Tb and ^{165}Ho were measured up to 30 MeV using quasi-"monochromatic" photons resulting from annihilation-in-flight For ^{181}Ta, measurements including (γ,4n) reactions up to 36 MeV were taken. An analysis of the experimental photoneutron multiplicity data shows that for 17 MeV < E_γ < 21 MeV the "direct effect" neutron contribution varies between 17 and 30%. All photoneutrons from (γ,2n) and (γ,3n) reactions are to be classified as "boiled" off neutrons. Quadrupole moments as well as Lorentz line parameters were also determined. (auth)

5914 THE DECAY OF ^{99}Mo. Van Eijk, C. W. E. (Technical Univ., Delft, Netherland); Van Nooijen, B.; Schutte, F.; Brahmavar, S. M.; Hamilton, J. H.; Pinajian, J. J. Nucl. Phys., A121: 440-62(1968).

The radioactive decay of 67-hr ^{99}Mo was studied by measuring internal conversion spectra, single gamma-ray spectra, and gamma-gamma coincidences. Large-volume Ge(Li) detectors, a curved-crystal spectrometer, a sector-field beta-ray spectrometer and a fast coincidence arrangement were employed in these experiments. The following gamma rays were observed (relative intensities are given in parentheses): 40.584 ± 0.002, 140.511 ± 0.006(100), 142.63 ± 0.03(0.03), 181.06 ± 0.04(7.5), 249 ± 1(0.006), 344 ± 2(0.0013), 366.4 ± 0.1(1.6), 380.7 ± 0.2(0.011), 409 ± 2(0.0016), 411.5 ± 0.5(0.027), 458 ± 1(0.006), 528.9 ± 0.2(0.06), 620.7 ± 0.2(0.027), 620.7 ± 0.2(0.005), 739.7 ± 0.1(15.4), 778.2 ± 0.1(5.4), 823.1 ± 0.1(0.16), 961.0 ± 0.2(0.12), 988.2 ± 0.5(0.002), 1001.7 ± 0.2(0.007) and 1016 ± 2 keV (0.001). The following energy levels were populated: 140.511 ± 0.006, 142.63 ± 0.03, 181.095 ± 0.007, 509.0 ± 0.1, 671.5 ± 0.2, 761.3 ± 0.2, 920.8 ± 0.1, 1004.2 ± 0.2, 1129.7 ± 0.2, 1142.1 ± 0.2, 1169.3 ± 0.5 and 1197 ± 2 keV. The levels at 671.5, 761.5, 761.3, 1004.2, 1142.1, 1169.3 and 1197 keV have not been reported previously. The following K-conversion coefficients were determined: α_K(140.5) = 0.104 ± 0.007, α_K(142.6) = 23 ± 6, α_K(181.1) = 0.130 ± 0.012, and α_K(739.7) = 1.6 ± 0.4 × 10^{-3}. (auth)

5915 THE ALPHA DECAY OF ^{253}Cf AND ^{254}Cf. Bemis, C. E. Jr.; Halperin, J. (Oak Ridge National Lab., Tenn.). Nucl. Phys., A121: 433-9(1968).

The alpha-branching decay of 17.6-day ^{253}Cf and 60.5-day ^{254}Cf was observed using sources of these activities produced by the intense neutron irradiation of ^{252}Cf followed by electromagnetic isotope separation. Alpha-particle energies and relative intensities are 5.979 ± 0.005 MeV, 94.7 ± 0.9%; 5.921 ± 0.005 MeV, 5.3 ± 1.9% for ^{253}Cf and 5.834 ± 0.005 MeV, 83 ± 1%; 5.792 ± 0.005 MeV, 17 ± 2% for ^{254}Cf. The alpha groups in ^{253}Cf decay populate the rotational band in ^{249}Cm arising from the Nilsson single-particle state, $\frac{7}{2}$[613↑]. The $\frac{7}{2}^+$ base state from the $\frac{7}{2}$[613↑] configuration was located at an excitation energy of 50 keV in ^{249}Cm. The partial alpha half-life for ^{254}Cf is 53.4 ± 2.7 y based on a total half-life of 60.2 ± 0.2 d. (auth)

5916 MEASUREMENTS ON FISSILE NUCLEI: EXPERIMENTAL RESULTS AND INTERPRETATION. Michaudon, A. (CEN, Saclay, France). pp 427-74 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

Some aspects of the interaction of resonance neutrons with fissile nuclei are discussed including cross-section measurements, data analysis and interpretation, quasi resonances, and subthreshold fission. 80 references. (D.C.W.)

5917 NORMALIZATION OF RELATIVE ^{235}U FISSION CROSS SECTIONS IN THE RESONANCE REGION. Deruytter, A. J. (EURATOM, Geel, Belgium); Wagemans, C. pp 475-80 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

Measurements were performed with the Linac of the CBNM in view of extending the Linac fission cross sections down to below thermal energy for a direct normalization to the previously determined absolute 2200-m/s reference cross section. The measurements are performed at a well-collimated short flight-path (about 8 meter) with low repetition rate and long burst-time of the Linac. The comparison of induced reaction rates in a back-to-back ^{235}U- and ^{10}B-foil is made simultaneously with two sets of solid-state detectors and registered in two halves of a 4096-channel time-of-flight analyzer. (auth)

5918 FISSION CROSS SECTION MEASUREMENT ON ^{235}U. Cao, M. G.; Migneco, E.; Theobald, J. P.; Wartena, J. A.; Winter, J. (EURATOM, Geel, Belgium). pp 481-90 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

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The cross section of the ^{235}U(n,f) reaction was measured with a high energy resolution for neutrons between 6 eV and 3 keV. A fission fragment and a fission neutron detector were used simultaneously. Resonance parameters for 78 levels between 6 and 150 eV are given. The statistical distributions of Γ_f, Γ_γ, and α were studied. (auth)

5919 PRECISE 2200 M/S FISSION CROSS-SECTION OF ^{235}U. Deruytter, A. J.; Spaepen, J.; Pelfer, P. (EURATOM, Geel, Belgium). pp 491-501 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

A precise measurement of the 2200-m/sec fission cross section of ^{235}U was performed with a slow chopper at the BR-2 reactor (energy range from 0.005 to 0.1 eV). Simultaneous recordings of pulse-height and time-of-flight spectra of successively compared ^{235}U F_4 layers and standard natural B layers were made. The detection of the ^{10}B(n,α)^{7}Li and ^{235}U(n,f) reaction fragments was made with excellent pulse-height resolution in low geometry with a surface-barrier detector. The relative ^{10}B contents of several standard B foils were checked by their neutron-induced reaction rates. The absolute ^{10}B contents were determined from direct weighing in vacuum combined with careful chemical and isotopic analysis of witness foils. The fission foils were checked by α and fission-fragment counting. (auth)

5920 MEASUREMENT OF THE ^{235}U FISSION CROSS SECTION IN THE keV ENERGY RANGE. Poenitz, W. P. (Argonne National Lab., Ill.). pp 503-11 of Neutron Cross Sections and

Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.–299(Vol.1); CONF-680307–(Vol.1).

The energy dependence of the fission cross section of ^{235}U was measured in the range 30 to 1500 keV. This dependence is important due to the increasing emphasis on fast reactors and due to the significance of this cross section as a standard in cross section experiments. The energy dependent shape was measured using a specially collimated beam of pulsed-monoenergetic neutrons derived from the $Li^7(p,n)Be^7$ reaction. The fission events were measured by means of a gas scintillation counter using a time-of-flight technique for background suppression. The relative neutron flux was measured using a beam catcher detector which had a flat efficiency curve in the energy range under consideration. The measured cross section shape was normalized at 30 keV to a cross section value taken from a recent absolute measurement by Knoll and Poenitz. The experimental results agree with some other measured cross section shapes in this energy range but tend to disagree at higher energies with the cross section values measured relative to the hydrogen scattering cross section by about 15 percent. (auth)

5921 SCATTERING CROSS SECTION OF ^{240}Pu. Cao, M. G.; Migneco, E.; Theobald, J. P.; Wartena, J. A. (EURATOM, Geel, Belgium). pp 513-18 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.–299(Vol.1); CONF-680307–(Vol.1).

The scattering cross section of ^{240}Pu was measured between 18 eV and 2.5 keV with a ^{10}B-loaded liquid scintillation detector. The Γ_n values of 14 resonances between 20.45 and 287.1 eV were determined, and the scattering resonance areas as well as the Γ_n values were compared with other measurements. (auth)

5922 FINAL RESULTS ON THE NEUTRON TOTAL CROSS SECTION OF ^{240}Pu. Kolar, W.; Boeckhoff, K. H. (EURATOM, Geel, Belgium). pp 519-26 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.–299(Vol.1); CONF-680307–(Vol.1).

The neutron total cross section of ^{240}Pu was measured with high resolution in the energy range 20 eV to 5.7 keV. Up to this energy 264 resonances were detected and were analysed with respect to Γ_n using the area program of Atta and Harvey. For 32 resonances between 38 eV and 820 eV the full set of resonance parameters E_r, Γ_n and Γ_γ could be evaluated by combining the results of the transmission experiment with those of a capture experiment. For the 102 resonances up to 1500 eV, a mean level spacing of $\langle D \rangle = 14.7$ eV was obtained. Presuming that all resonances in that range are of the s-type, the strength function yields $S_0 = 1.05 \pm 0.16 \times 10^{-4}$. (auth)

5923 RESONANCE GROUPING STRUCTURE IN NEUTRON INDUCED SUBTHRESHOLD FISSION OF ^{240}Pu. Migneco, E.; Theobald, J. P. (EURATOM, Geel, Belgium). pp 527-32 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.–299(Vol.1); CONF-680307–(Vol.1).

The subthreshold fission cross section of ^{240}Pu was measured in the energy range between 200 eV and 8 keV. The fission spectrum obtained shows a periodical appearance of groups of resonances with particularly high fission widths. The mean fission cross section is higher than the calculated value for p-wave fission. (auth)

5924 NEUTRON CAPTURE MEASUREMENTS IN THE RESONANCE REGION: Cu AND ^{240}Pu. Weigmann, H.; Winter, J.; Schmid, H. (EURATOM, Geel, Belgium). pp 533-40 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.–299(Vol.1); CONF-680307–(Vol.1).

Radiative neutron capture in natural Cu was studied in the neutron energy range from 200 eV to 16.5 keV. An area analysis of the data yields information on resonance parameters: For large resonances ($\Gamma_n \gg \Gamma_\gamma$) with known isotopic assignment values of Γ_γ or, if the spin of the resonance is unknown, $2g\Gamma_\gamma$ are obtained. In some cases, it was possible to assign the spin of the resonance from the measured $2g\Gamma_\gamma$ assuming a fairly constant radiation width. For a number of small resonances ($\Gamma_n \ll \Gamma_\gamma$) with unknown isotopic assignment, values of $4ag\Gamma_n$ (a = isotopic abundance) have been determined. The radiative widths obtained for 32 resonances in ^{240}Pu in the neutron energy range between 38 eV and 820 eV are also given, yielding a mean value of $\overline{\Gamma}_\gamma = 23.2 \pm 2.0$ meV. The observation of unusual large radiative widths for some resonances is explained by the presence of subthreshold fission. (auth)

5925 FISSION CROSS-SECTION MEASUREMENTS: PRESENT AND POTENTIAL CAPABILITIES. Farrell, J. A. (Los Alamos Scientific Lab., N. Mex.). pp 553-65 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.–299(Vol.1); CONF-680307–(Vol.1).

The current techniques of measuring the neutron cross sections of the fissionable nuclei are discussed and are compared, along with possible improvements in the future. The different methods of determining resonance parameters from the cross section data are considered. Recent experiments that have yielded information on the properties of the deformed transition nucleus are also discussed. (auth)

5926 NEUTRON INDUCED FISSION CROSS-SECTION MEASUREMENTS IN ^{244}Cm. Fullwood, R. R.; McNally, J. H.; Shunk, E. R. (Los Alamos Scientific Lab., N. Mex.). pp 567-72 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.–299(Vol.1); CONF-680307–(Vol.1).

The neutron-induced fission cross section in ^{244}Cm was measured in March 1967 using a 305.2-m flight path and a nuclear explosive as the pulsed neutron source. A report of these measurements at a laboratory angle of $55° \pm 16$ using manually digitized film readings and covering a neutron energy range from 2 MeV to 20 eV is presented. A 205 μg sample of 95% ^{244}Cm was used. The fission threshold is observed to occur at about 710 keV, and subthreshold fission is clearly seen. Because of uncertainties in the quantity of curium and because of the low signal level, the standard deviation of the cross section is claimed to be ±30% except in the valleys between resonances where no information is obtained. (auth)

5927 MEASUREMENT OF THE ABSOLUTE VALUE OF ETA FOR ^{241}Pu BY THE MANGANESE BATH METHOD. Smith, J. Richard; Reeder, S. Darrel (Idaho Nuclear Corp., Idaho Falls). pp 589-96 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.–299(Vol.1); CONF-680307–(Vol.1).

The absolute value of eta for ^{241}Pu was measured using the manganese bath technique. The MTR crystal spectrometer provided monoenergetic neutrons for measurements at 0.0253 eV and 0.060 eV. Purity of the monochromatic beam was insured by the operation of a mechanical neutron filter in the Bragg beam. The measurement consisted of comparing the ^{56}Mn activity induced in the solution by the neutron beam with the activity induced by fission neutrons emitted when the low-energy beam was absorbed in the fissile sample. Additional manganese bath measurements were also made on ^{233}U, ^{235}U, and ^{239}Pu at both neutron energies to complete a detailed intercomparison of the four fissile isotopes. A least-squares analysis is being made of the experimental data to determine the best values of eta, the eta ratios, and their associated errors. (auth)

5928 FRAGMENT ANGULAR DISTRIBUTIONS FOR MONOENERGETIC NEUTRON-INDUCED FISSION OF ^{239}Pu. Huizenga, J. R. (Univ. of Rochester, N. Y. Argonne National Lab., Ill.); Behkami, A. N.; Meadows, J. W. Jr.; Klema, E. D. pp 603-10 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.–299(Vol.1); CONF-680307–(Vol.1).

Fission fragment angular distributions were measured for the fission of ^{239}Pu induced by monoenergetic neutrons of energies 150, 400, 475, 550, 600, 700, 800, 900, 1000, and 1200 keV (energy resolution ±25 keV). The fission fragments were detected with solid state silicon detectors at six angles simultaneously, namely, 3.7, 24.0, 37.2, 54.7, 72.3 and 90.0°. The relative sizes of the detectors were determined in an identical configuration with thermal

neutrons. For various sets of optical model neutron transmission coefficients, the values of $K_{\frac{1}{2}}^2$ (the projective K of the total angular momentum I on the nuclear symmetry axis is assumed to have a Gaussian distribution, and $K_{\frac{1}{2}}^2$ is the squared standard deviation of the Gaussian) were calculated from the experimental angular distribution at each neutron energy. The excitation energy dependence of $K_{\frac{1}{2}}^2$ is discussed in terms of the nuclear pairing energy of the highly deformed transition nucleus. (auth)

5929 FISSION CROSS SECTION OF ^{232}Th FOR THERMAL NEUTRONS. Neve de Mevergnies, M.; del Marmol, P. (CEN-SCK, Mol, Belgium). pp 611-13 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

The thermal neutron fission cross section of ^{232}Th was measured using Makrofol-E solid-state counters to register the tracks of fission fragments. The Makrofol disks were held tightly against the Th deposits in an Al or Cd box and were irradiated in the vertical thermal column of the BR-1 graphite reactor operating at medium power. The weighted average value of the cross section for 2 runs was 39 ± 4 μ barn. (D.C.W.)

5930 A SINGLE LEVEL ANALYSIS OF ^{233}U CROSS SECTIONS. Schneider, M. J. (Westinghouse Electric Corp., Pittsburgh). pp 615-25 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

Experimental cross sections for neutrons on ^{233}U were fitted with a single-level Breit-Wigner least squares analysis from 0.4 to 61.4 eV. The total cross section measurements by Pattenden and Harvey, and the simultaneously measured capture and fission cross sections of Weston, et al., were used. All three cross sections were fitted simultaneously. Doppler broadening and experimental resolution were accounted for by using an effective sample temperature greater than its actual temperature. Sixty-three resonances were found in this energy range, and with them the data can be well reproduced. Resonance curves, plots of alpha vs energy, the resonance parameters, and brief statistical analyses of them are presented. Some disagreement is found between the present parameters and those recommended in BNL-325. (auth)

5931 LOW-ENERGY ^{235}U $\bar{\nu}$ MEASUREMENTS. Weinstein, S.; Block, R. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. pp 635-40 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

A method was developed for high-resolution measurements of the variation of $\bar{\nu}$ with incident neutron energy. The system utilizes the Rensselaer LINAC as a source of neutrons, a multiplate ionization chamber to detect fission fragments, and a 0.75-m gadolinium-loaded liquid scintillation tank to detect the prompt fission neutrons. The data is processed and stored in a PDP-7 on-line computer, with up to 12 values of multiplicity allowed for both fission and background events associated with each time-of-flight channel. For the energy region from 0.012 eV to 40.0 eV, it was found that, to within 0.25%, the values of $\bar{\nu}$ for ^{235}U do not differ from the value at 0.0253 eV. (auth)

5932 SUM-PEAK-COINCIDENCE SPECTROMETER AND GAMMA-GAMMA ANGULAR CORRELATION STUDIES IN ^{133}Cs. Sud, S. P.; Mangal, P. C.; Suri, K. K.; Trehan, P. N. (Panjab Univ., Chandigarh, India). Indian J. Phys., 42: 167-74(Mar. 1968).

A sum-peak-coincidence spectrometer was set up to study the directional correlation of 356-82 keV and 276-162 keV cascades in ^{133}Cs following the decay of ^{133}Ba. The correlation functions for those cascades support spin assignments of $\frac{1}{2}^+$ for the 438-keV level and $\frac{5}{2}^+$ for the 162-keV level in ^{133}Cs. The mixing ratios for the 82-keV and 162-keV transitions were found to be 97.2 ± 0.3% M1 + 2.8 ± 0.3% E_2 and 75.8 ± 3.2% + 24.2 ± 3.2% E_2, respectively. (auth)

5933 MEASUREMENTS OF THE LONGITUDINAL DEPOLARIZATION OF ^{198}Au β PARTICLES WITHIN THE SOURCE. Schwarz, Guenther R.; Loehken, Rudolf; Rebel, Heinigerd (Univ., Heidelberg). Z. Phys., 217: 465-84(1968).

Depolarization measurements are reported for 0.45-, 0.54-, and 0.75-MeV β particles emitted from ^{198}Au sources up to 17 mg/cm^2 thick. The degree of polarization is measured by using a double scattering apparatus and very thin ^{32}P samples as reference. The observed depolarization proves to be larger than estimated by theoretical calculations. Moreover, it is confirmed that the polarization values of the electrons emitted in the β decay of ^{198}Au ($2^- \rightarrow 2^+$ transition to the 0.412-MeV level of ^{198}Hg) and of ^{32}P do not differ significantly. (auth)

5934 ORIGIN OF THE HEAVY NUCLEI. Amiet, J. P. (Univ., Heidelberg); Zeh, H. D. Z. Phys., 217: 485-509(1968).

Nuclear formation processes and the conditions of their physical environment are investigated on the basis of the empirical abundance distribution of the nuclei. Three different abundance components of the heavy nuclei require very different physical conditions for their formation but appear genetically correlated. The component formed in a slow neutron capture chain indicates the pre-existence of the neutron-rich component, and of an iron abundance peak considerably smaller than found in the solar system. The neutron-rich and the proton-rich components seem to have been formed by β-decay from progenitors which were produced at conditions of matter density $\rho \approx 2 \times 10^{10}$ g/cm^3 and of temperature kT ≈ 500 keV, respectively. (auth)

5935 CHANGE OF THE MEAN SQUARE NUCLEAR CHARGE RADIUS IN ROTATIONAL EXCITATION. Henning, W. (Technische Hochschule, Munich). Z. Phys., 217: 438-56(1968). (In German).

Isomer shifts of γ rays from rotational bands of deformed nuclei were determined in Moessbauer effect measurements. The changes of the mean square nuclear charge radii were deduced. The results are compared with theoretical calculations and additional experimental data to study the effect of the Coriolis and centrifugal forces in rotational excitation on the motion of the nucleons. (auth)

5936 EXPERIMENT ON THE ISOTROPY OF ALPHA-ALPHA ANGULAR CORRELATION IN THE SERIAL DECAY OF ^{228}Th AND ^{226}Ra. Biswas, M. M.; Gupta, B. K.; Sen, P. K.; Bhattacharya, P. C. (Univ. of Calcutta). Z. Naturforsch., 23a: 1673-4(Oct. 1968).

Experiments on the angular correlation between consecutive alphas emitted in the serial decay of ^{228}Th and ^{226}Ra were performed on the stars produced in emulsion. The correlation distributions follow isotropy. (auth)

5937 THE DECAY OF ^{139m}Nd. Hesse, K. (Institut fuer Technische Kernphysik, Darmstadt, Ger.). Z. Naturforsch., 23a: 1668-70(Oct. 1968).

A revised level scheme is proposed for ^{139}Pr with the following excited levels: 113.9, 821.9, 828.0, 851.9, 1024.0, 1369.9, 1447.8, 1523.0, 1624.4, 1834.0, 1926.8, 2048.6, 2174.4. 2196.4 and 2292.2 keV. Both γ-ray energies and intensities are given, and log ft values for the β decay of ^{139m}Nd are estimated. (auth)

5938 INFLUENCE OF ENERGY ON DE-EXCITATION PROCESSES FOR MEDIUM AND HEAVY NUCLEI. Gatty, Bernard; Lefort, Marc; Tarrago, Xavier (Institut de Physique Nucleaire, Orsay, France). J. Phys. (Paris), 29: 705-21(Aug.-Sept. 1968). (In French).

A study has been made of the charged particles emitted from target nuclei Ag, Ta, Au, Pb, Bi and Th, bombarded by 156-MeV protons. The energy and angular distributions for protons, deuterons, tritons, and helions have been carried out using a telescope device of solid state detectors. The particles were identified by simultaneous measurements of $\Delta E/\Delta\chi$ and E values followed by a bidimensional analysis. Energy and angular distributions were found to depend very much on the emitting process and it was possible to distinguish the collective de-excitation process from direct interaction. Therefore, the de-excitation of very excited nuclei was specially studied. Calculations were performed on the basis of the statistical theory. The evaporation was followed in an analytical way, starting with the compound nuclei, down to the de-excited residual product. From the good agreement with the experimental data, it was concluded that the main parameters, the level density and the inverse cross-section were correctly estimated. It was shown that the level density parameter is the same as at low energy and therefore the hypothesis on the Fermi gas holds even at 100 MeV. The inverse cross section has been taken from optical model data applied to a diffuse edge nucleus. The question of the thermodynamical equilibrium for very excited nuclei has been discussed. (auth)

5939 LIFETIMES OF 113- AND 321-keV LEVELS OF ^{177}Hf. Narasimha Rao, B. V.; Jnanananda, Swami (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys., 6: 555-7(Oct. 1968).

The lifetimes of the 321- and 113-keV levels of ^{177}Hf were measured with a delayed coincidence spectrometer to be 647 ± 32 and 523 ± 25 psec, respectively. The experimental transition probabilities of the three E1 transitions decaying from the 321-keV level are compared with the single-particle as well as Nilsson estimates, and a good agreement is found with the latter. (auth)

5940 HALF-LIFE OF THE 181-keV LEVEL OF ^{99}Tc. Rama Rao, M. T.; Ramamurty, V. V.; Lakshminarayana, V. (Andhra

Univ., Waltair, India). Indian J. Pure Appl. Phys., 6: 553-5(Oct. 1968).

The half-life of the 181-keV level in ^{99}Tc was measured by the delayed coincidence method using a time-to-amplitude converter. By observing the 740–181 keV γ-γ coincidences and using the slope method, the half-life of the level was determined to be 3.42 ± 0.10 nsec. The E2 transition probability for the state was estimated and was found to show an enhancement of 8.2 ± 1.3 over the single-particle estimate. On the basis of the observed enhancement, a pure configuration $(P_{\frac{1}{2}})^2(g_{\frac{9}{2}})^3$ for the 181-keV level was rejected. Assuming the ground and 181-keV states of ^{99}Tc to be described by pure De-Shalit wave functions, it was observed that the B(E2) value expected from these wave functions is in good agreement with the experimental value. Alternatively, the B(E2) value for the level was estimated using the ground-state wave function of Kisslinger and Sorensen (Rev. Mod. Phys., 35: 853(1963)) and a pure De-Shalit wave function for the 181-keV level. A slight modification of the amplitudes of the particle and particle + phonon parameters in the ground-state wave function was required to obtain exact agreement with the experimental B(E2) value. The core + many particle model does not seen to apply to the 181-keV level. (D.C.W.)

Nuclear Theory

Refer also to abstracts 5483, 5550, 5557, 5640, 5751, 5776, 5807, 5810, 5818, 5841, 5850, 5853, 5871, 5874, 5877, 5882, 5885, 5890, 5904, and 5925.

5941 (COO–1764-30) AN AVERAGE SET OF OPTICAL TRITON PARAMETERS OBTAINED FROM THE FIT OF (t,p) ANGULAR DISTRIBUTIONS. Barz, H.-W.; Hehl, K.; Riedel, C. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)); Broglia, R. A. (Minnesota Univ., Minneapolis. School of Physics). Aug. 1968. 23p. Dep. CFSTI.

The angular distributions of (t,p) reactions leading to 0^+ and 2^+ states in ^{50}Ca, ^{65}Cu ($\frac{3}{2}^-$ L = 0 ground state and $\frac{5}{2}^-$ L = 2 state), ^{120}Sn, ^{156}Sm, ^{210}Pb, and ^{240}U were fitted to derive 12-MeV optical triton parameters. A mass-independent set of potential parameters was obtained which gives good agreement between theory and experiment for all nuclei considered. This set of parameters is suitable to reproduce the shape of angular distributions for L > 2. The influence of different triton parameters on relative cross sections is discussed. (auth)

5942 (IAE–1426) NONLOCAL INTERACTIONS IN EQUATIONS FOR AN EFFECTIVE FIELD. ISOTOPIC DISPLACEMENT. Sapershtein, E. E.; Khodel V. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1967. 11p. (In Russian). Dep.

An investigation is made of the behavior of the Fermi system in an external field when the interaction forces between quasiparticles are not pointlike, i.e., the non-zero harmonics of the decomposition of the interaction amplitude of quasiparticles in accordance with the Legendre polynomials are not small. (auth)

5943 (IPNO/LA–68/24) ON THE NUMBER-CONSERVING TREATMENT OF THE PAIRING INTERACTION. Dang, G. Do (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Aug. 1968. 6p. Dep.

A method of solution by iteration is given in the number-conserving treatment of the pairing interaction. It is local in the sense that a single nucleus is involved in the calculations. (auth)

5944 (JINR–P2-4068) CROSS SECTIONS FOR FAST PARTICLES AND THE ATOMIC NUCLEI. Barashenkov, V. S.; Gudima, K. K.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 73p. (In Russian). Dep.

A summary is given of the available experimental data on the total cross sections and the elastic and inelastic cross sections of nucleons, antinucleons, π-mesons, and K-mesons with atomic nuclei in the range of the energies above 50 MeV. The cross sections of the nucleus-nucleus interactions are pointed out (for kinetic energies above 50 MeV/nucleon). The experimental data are discussed. 169 references. (auth)

5945 (NAS-NS–3112) ABSOLUTE MEASUREMENT OF ALPHA EMISSION AND SPONTANEOUS FISSION. Brouns, Richard J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1968. Contract AT(45-1)-1830. 60p. Dep. CFSTI.

Nuclear Science Series of the National Academy of Sciences–Research Council, Washington, D. C. Committee on Nuclear Science.

A survey of techniques for absolute measurement of α emission and of spontaneous fission events is presented. Source preparation and calibration, counter design and calibration, and counting geometry are discussed. 104 references. (D.C.W.)

5946 (ORO–3765-1) PROGRESS REPORT FOR THE EXPERIMENTAL AND THEORETICAL STUDY OF THE STRUCTURE OF NUCLEI AND THE INTERACTIONS OF INTERMEDIATE ENERGY PARTICLES. MacDonald, William (Maryland Univ., College Park). Oct. 1, 1967. Contract AT(40-1)-3765. 11p. Dep. CFSTI.

Unified reaction theory was applied to reactions proceeding through the compound nucleus ^{16}O, and a theory of analog resonances was developed in which the intermediate resonance states are described by shell-model wave functions. The statistical theory of complex nuclear reactions was studied, as was the liquid drop theory of fission. The energy dependence of the imaginary potential for coupled-channel calculations was investigated for the case of the reaction ^{15}N(p,γ_0)^{16}O. Fits of N–N interaction models to p–p scattering data below 330 MeV were made. Charge splitting of the $^1S_0$ state for n–p and p–p scattering was investigated; evidence for charge dependence of the N–N interaction was obtained. An extensive investigation of the properties of light nuclei was undertaken through self-consistent Hartree–Fock and Hartree–Fock–Bogoliubov calculations, primarily for even-even sd-shell nuclei. (D.C.W.)

5947 ODD NUCLEI, THE PARTICLE–PHONON INTERACTION, AND THE CONSERVATION LAWS. Da Providencia, J. (Univ. of Coimbra, Portugal). Phys. Lett., 28B: 88-9(Nov. 11, 1968).

It is shown that the particle-phonon interaction tends to restore to an odd-nucleus collective Hamiltonian the general invariance properties lost in the Hartree-Fock approximation. (auth)

5948 NOTE ON THE CONVERGENCE OF THE BELYAEV–ZELEVINSKII EXPANSION. Da Providencia, J. (Univ. of Coimbra, Portugal). Phys. Lett., 28B: 82-4(Nov. 11, 1968).

It is argued that some RPA modes can not be described, even approximately, by boson operators. If one wants to describe the RPA modes by boson operators, it is necessary either first to eliminate the undesirable modes or else to correct for their contribution. The argument is illustrated by applying the Beliaev-Zelevinsky expansion to a calculation of the correlation energy of a solvable model. (auth)

5949 PROTON–PROTON BREMSSTRAHLUNG AT 3.2 AND 10 MeV: THEORY. Signell, P. (Michigan State Univ., East Lansing); Marker, D. Phys. Lett., 28B: 79-81(Nov. 11, 1968).

The proton-proton bremsstrahlung cross section is found to be very accurately given at 10 MeV by the on-energy-shell approximation, making it completely model-independent. Values obtained from various theoretical calculations are compared, several of which seem to contain gross errors. (auth)

5950 FINE STRUCTURE OF GIANT RESONANCES. Shapiro, I. S. JETP Lett. (USSR) (Engl. Transl.), 8: 95-7(Aug. 5, 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 158-61(Aug. 5, 1968).

It is shown that the fine structure of the giant resonance in reaction cross sections is due to the unitarity relation. The physical cause is essentially the resonant rescattering in the initial and final states. (J.W.R.)

5951 INVESTIGATION OF THE FACTOR U^{-n} IN THE LEVEL DENSITY FORMULA OF THE FERMI-GAS MODEL. Penssel, H.-J.; Hofmann, A. (Univ., Erlangen, Ger.). Z. Phys., 217: 247-55(1968). (In German).

The nucleus considered as a Fermi-gas is supposed to consist of several subsets of fermions with a constant number of nucleons in each subset. With this assumption the exponent n in the level density formula $p(U) \sim U^{-n} \exp(2\sqrt{aU})$ is found to increase by 0.25 per additional subset. (auth)

5952 INVESTIGATION OF THE COLLECTIVE POTENTIAL-ENERGY SURFACE. Mosel, Ulrich; Greiner, Walter (Univ., Frankfurt am Main). Z. Phys., 217: 256-81(1968).

The structure of the collective potential-energy surface is discussed. By use of its rotational invariance, it is possible to determine the surface explicitly without the necessity of calculating all points in the a_0-a_2-plane microscopically. The contributions of three essential parts, namely the single particle-stiffness, the pairing interaction and the Coulomb force, are thoroughly investigated. The surface is compared with experimental data in the rare-earth region and yields important results for the structure of the collective vibrations in these nuclei. (auth)

5953 A THEORY OF ANHARMONIC VIBRATIONS IN SPHERICAL EVEN–EVEN NUCLEI. Kishimoto, Teruo; Ikeda, Kiyomi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 40: 499-522(Sept. 1968).

Unexpectedly large quadrupole moments of the first 2^+ states of the vibrational nuclei lead to treatment of these states as collective states of anharmonic vibrations. The time-dependent perturbation theory using the adiabatic approximation is applied to obtain the phonon Hamiltonian for the anharmonic motion. Advantages of this treatment are that the collective vibration with a low frequency can be well described, it is easy to derive higher order anharmonic terms and the connection with the static deformation becomes evident. The generalized collective coordinate for the treatment of anharmonic terms is introduced. It is defined by adopting the principle of the linked cluster expansion. The Hamiltonian is obtained so that it has the form of a rapidly converging expansion series in terms of the generalized collective coordinate and its conjugate momentum. Finally quantization is performed, which leads to the phonon-picture. Typical features of the resulting Hamiltonian for the anharmonic vibration are discussed. (auth)

5954 EFFECTIVE INTERACTION IN A NUCLEAR MODEL. Mueller, Dieter (Technische Univ., Hanover). Z. Phys., 217: 386-405(1968).

The effective interaction U belonging to a given subspace of n unperturbed model functions can be related to the free nucleon-nucleon interaction by means of an exact integral equation. The conditions for a Born–von Neumann expansion of U and for an approximation by a slowly energy-dependent interaction with adjustable parameters are investigated. It appears that effective interactions which have been used successfully in shell-model calculations of bound-state properties do not necessarily describe the actual dynamics of a nucleus. (auth)

5955 THREE PARTICLE MODEL FOR NUCLEAR TRANSFER REACTIONS. El-Batanoni, F.; Rihan, T. H. (Atomic Energy Establishment, Cairo). Atomkernenergie, 13: 421-4(Nov.-Dec. 1968).

The second iterative solution to the Fadeev equations is applied to the case of nuclear transfer processes. It is shown that, after retaining the two-body interactions and adopting some reasonable approximations, the transition amplitude may be obtained in an analytic form. The results are applied to the case of $^{28}Si(d,p)^{29}Si$ stripping reaction. Good agreement is obtained for both the angular distribution and the extracted reduced widths. (auth)

5956 PERIPHERAL MODEL OF DIRECT NUCLEAR REACTIONS. Borbei, I.; Dolinskii, E. I.; Turovtsev, V. V. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 8: 492-506(Sept. 1968). (In Russian).

A peripheral model is proposed to describe direct nuclear reactions of the type A(x,y)B. Simple formulas for differential cross sections of direct reactions occurring by means of the pole mechanism are obtained in framework of this model, and a series of qualitative regularities in the angular distributions which can be checked experimentally are predicted. The angular distribution of protons from the reaction $^{10}B(d,p)^{11}B$ (ground) was calculated as an example. The peripheral model is compared with the Butler theory and with the diffraction models by Henley, Yu and Dar. (auth)

5957 POLARIZABILITY AND THE ELASTIC SCATTERING OF α PARTICLES. Kadmenskii, S. G. (Voronezh State Univ., USSR). Yadern. Fiz., 8: 486-91(Sept. 1968). (In Russian).

Analytic expressions for the real and imaginary parts of the optical potential for a particles disregarding polarizability are constructed on the basis of expansion of one-nucleon potentials into a series on internal coordinates for α particles. Geometrical parameters and potential depths are found when the forms of this potential are approximated by the Fermi function. In particular, for $A = 125$ and for low energies of α particles, in the case of the volume absorption $V_0 \approx -200$ MeV, $W_0 \approx -20$ MeV, $\alpha^{\alpha} = 0.9$ Fermi, and $r_0^{\alpha} = 1.2$ Fermi. It is shown that at energies satisfying the condition $E_{\alpha} \ll 400$ MeV, the adiabatic approximation is valid. An addition to the optical potential is calculated, which is found to be appreciable and may result in deviation of the form of the optical potential from the Woods–Saxon potential. (auth)

5958 MAGNETIC DIPOLE MOMENTS OF NUCLEI IN THE WIGNER SUPERMULTIPLET APPROXIMATION. Petrauskas, A. K.; Vanagas, V. V. (Inst. of Physics and Mathematics, Vilnyus, USSR). Yadern. Fiz., 8: 463-9(Sept. 1968). (In Russian).

Explicit formulas are obtained for calculating nuclear magnetic dipole moments. It is shown that in the Wigner supermultiplet approximation the matrix elements of the magnetic dipole moment operator depends slightly on the detailed shape of the orbital wave function of the nucleus. The calculated magnetic moments for several series of nuclei, with the orbital ground state described by the Young pattern [44...4k] (k = 0, 1, 2, 3) are compared with experimental values. (auth)

5959 FACTORIZATION OF MANY-PARTICLE FRACTIONAL PARENTAGE COEFFICIENTS. Smirnov, Yu. F.; Shitikova, K. V.; El'-Samarai, S. Kh. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 8: 470-6(Sept. 1968). (In Russian).

The problem of separation of the many-particle fractional parentage coefficients into the orbital and the spin-isospin parts that are necessary for considerations of many-particle forces in nuclei, for calculations of the reduced t, ^3He, and α widths, etc., is solved for the general case. Formulas for the orbital and spin-isospin fractional parentage coefficients are given. A new method for calculation of the Clebsch–Gordan coefficients for the permutation group using the Young operators is described. (auth)

5960 VARIATION OF QUADRUPOLE MOMENT OF DEFORMED NUCLEI DUE TO ROTATION. Grin, Yu. T.; Pavlichenkov, I. M. Yadern. Fiz., 8: 477-85(Sept. 1968). (In Russian).

Variation of the quadrupole moment of even-even deformed nuclei due to the rotation is calculated in terms of the superfluid nuclear model taking into account the quadrupole-quadrupole interaction between nucleons. It is shown that the variation of the quadrupole moment is caused by two effects, i.e., by rearrangement of particles due to coupling of the rotation to one-particle degrees of freedom of nucleons, and the coupling of rotation to β-oscillations. Relative contributions of these effects depends on the ratio of frequency of β-oscillations to the energy of the pair correlation. Calculations of the variation of the quadrupole moment performed for the oscillator potential and for the rectangular well are compared with the experiment. (auth)

5961 QUASI-ELASTIC ELECTRON SCATTERING ON LIGHT NUCLEI. Malecki, A.; Picchi, P. (CNEN, Frascati, Italy). Nuovo Cim., 58A: 145-59(Nov. 1, 1968).

Quasi-elastic electron scattering on nucleons bound in light nuclei is considered using the electron-nucleon interaction of McVoy and Van Hove. The shell model with the harmonic-oscillator potential is assumed to describe the bound nucleons in the initial state. The outgoing nucleon is represented by a plane wave and the probability of the nucleon reabsorption is taken into account by means of a reduction factor. Comparison of the quasi-elastic scattering contribution with the inelastic, experimental cross section for ^4He, ^{12}C and ^{16}O is presented. The importance of possible effects of short-range nucleon-nucleon correlations is discussed. (auth)

5962 TECHNIQUE FOR PRECISION MEASUREMENTS OF NUCLEAR MOMENTS IN FREE ATOMIC IONS. Mitchell, Jerry K.; Fortson, E. Norval (Univ. of Washington, Seattle). Phys. Rev. Lett., 21: 1621-3(Dec. 9, 1968).

The first accurate measurements of nuclear moments in free atomic ions are now possible using an optical-pumping, exchange-collision method. In an experimental application of the method to Rb^+, linewidths of a few hertz have been obtained. (auth)

5963 THE DYNAMICS OF DIRECT NUCLEAR REACTIONS OF THE (d,p) TYPE. Kroha, Vaclav; Piskor, Stepan (Inst. for Nuclear Studies, Rez, Czech.). Cesk. Cas. Fys., 18: 511-39 (1968). (In Czech).

A review devoted to the study of the mechanism of (d,p) reactions is presented. The reliability of the present theory of this interaction, the reproducibility of the shape, and the magnitude of the differential effective cross section of the reaction are discussed; and a comparison with some experimental results is carried out. Some possible experiments, suitably complementing information obtained from the angular arrangement, namely of the spectroscopic characteristics as well as the mechanism of the reaction itself, are considered. 55 references. (auth)

5964 SPECTROSCOPIC FACTORS FROM (d,p) REACTIONS. Butler, S. T.; McKellar, B. H. J. (Univ. of Sydney). Phys. Rev. Lett., 21: 1533-5(Nov. 25, 1968).

The recent communication by Garcia and Pearson, of the same title as this note, is examined and is shown to contain an error. The conclusions drawn by Garcia and Pearson are therefore incorrect. (auth)

5965 POSSIBILITY OF ANOTHER DYNAMICAL EFFECT IN MUONIC ATOMS. Sundaresan, M. K.; Srinivasan, V. (Carleton Univ., Ottawa). Phys. Rev. Lett., 21: 1509-10(Nov. 25, 1968).

The possibility of a new dynamical effect in muonic lead arising from the excitation of discrete nuclear dipole states just below the neutron separation energy is discussed. The effect although small may be observable in high-resolution work. (auth)

5966 GERADE–UNGERADE SYMMETRY AND THE NUCLEAR MASS DIVISION IN FISSION. Griffin, James J. (Univ. of Maryland, College Park). pp 975-1012 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.–299(Vol.2); CONF-680307–(Vol.2).

The problem of describing the mass division in fission is reviewed. It is proposed that in the first approximation the most probable ratio is the ratio near the saddle point shape of the number of nucleons in gerade orbits [symmetric under reflection in the plane perpendicular to the nuclear axis] to the number in ungerade orbits. A description of nuclear fission as a process in which deformation proceeds slowly in the early stages and very rapidly between the saddle and scission shapes is suggested as the appropriate basis for the above proposal. The resulting model predicts asymmetric fission for high-Z and symmetric fission for low-Z elements. It provides, in addition, a host of implications for further exploration, some of which are touched upon briefly. It also provides an appropriate context into which shell effects may be considered as a second order influence. (auth)

5967 DETERMINATION OF THE OPTICAL POTENTIAL DEPTH FROM A MANY BODY APPROACH. Azziz, Nestor (Westinghouse Electric Corp., Pittsburgh). pp 943-9 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.–299(Vol.2); CONF-680307–(Vol.2).

It is known by the theory of nuclear matter that the average nuclear potential, i.e., the average potential seen by a nucleon in the nucleus, is nonlocal. With the aim of resolving the bound state problem and/or scattering problems, many nonlocal potentials have been proposed which more or less account for the actual average potential in nuclear matter. More often, however, a local potential with parameters depending on the energy of the nucleon is used as a tool for nuclear scattering and bound state predictions. The calculations with this local potential are much simpler than those using a nonlocal potential since the latter entails the solution of an integral-differential Schroedinger equation. The uncertainty and variety of local parameters is of great concern. The most unfortunate consequence of these uncertainties is the fact that quite often the resulting value of a parameter will disagree with predictions from more fundamental models of the nucleus. The depth of the nuclear potential at the center of the nucleus was derived from first principles with energy-dependent parameters using the theory of nuclear matter. (auth)

5968 NUCLEAR THEORY AND NEUTRON CROSS SECTIONS. Vogt, Erich (Univ. of British Columbia, Vancouver). pp 903-21 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.–299(Vol.2); CONF-680307–(Vol.2).

The use of the theory of nuclear structure in the calculation of neutron cross sections is discussed and is demonstrated by a few examples. The reciprocal interaction between the theory of nuclear structure and cross-section calculations is stressed. (D.C.W.)

5969 CORRELATIONS IN POSITIONS OF SINGLE-PARTICLE LEVELS ON COMPLEX NUCLEI. Sukhoruchkin, S. I. (Inst. for Theoretical and Experimental Physics, Moscow). pp 923-32 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.–299(Vol.2); CONF-680307–(Vol.2).

In the statistical description of complex nuclear spectra, the possible shell effects in level spacing distributions are supposed to be small and to be neglected. Positions of low-lying excited states of broad scope of nuclei and strong neutron resonances were analyzed. It appears that even with all nuclei being considered simultaneously, in both groups of the data one can see correlations characterized by a single interval close to 30 keV. Excluding rotational states prominent grouping effect in low-lying states was found by 30, 90, 150, 390, 510, and 780 keV. A small interval can be directly seen in a series of odd-odd nuclei as ground-state splittings. Correlation analysis of nucleon binding energies, strong electromagnetic transitions energies, and positions of highly excited levels of lead was carried out on computer; and an interval of 60 keV was found. Attention was drawn to the fact that two of three most prominent intervals (390, 510, and 780 keV) turn to are close to the mass splitting of elementary particles (511 keV, rest mass of electron; 782 keV, neutron beta-decay energy). (auth)

5970 ANALOG STATE RESONANCES. Mekjian, A.; MacDonald, W. M. (Univ. of Maryland, College Park). Contract ORO-3765-6. Nucl. Phys., A121: 385-421(1968).

A theory of analog state resonances is presented based on a K-matrix formulation of the shell-model theory of nuclear reactions. After deriving the detailed structure of the analog state and the "configurational states" of Lane and Soper, the "internal" mixing of the analog state to the configurational states is discussed. A shell-model description of "external" mixing is then given. In contradiction to earlier suggestions that internal mixing is unimportant, it is concluded that internal mixing cannot be neglected. The distribution of partial widths for the fine structure resonances is also derived. The structure of the fine structure states is discussed, and the various coupling mechanisms that can exist between the analog state and these states are established. The internal and external mixing of these different isospin states is treated on an equal footing, and the effect of each on the distribution of widths is discussed. Expressions for the average cross section for the one- and many-open channel cases are derived. A numerical discussion of the $p_{\frac{1}{2}}$ analog resonance in ^{41}K is given. (auth)

5971 MATRIX ELEMENTS OF THE NUCLEON–NUCLEON POTENTIAL FOR USE IN NUCLEAR-STRUCTURE CALCULATIONS. Elliott, J. P.; Jackson, A. D.; Mavromatis, H. A.; Sanderson, E. A.; Singh, B. (Univ. of Sussex, Brighton, Eng.). Nucl. Phys., A121: 241-78(1968).

The experimental nucleon–nucleon phase shifts were used to deduce matrix elements of the nucleon–nucleon potential in a basis of harmonic oscillator wave functions of the interparticle distance. Extensive tables are given for each partial wave. The method is essentially a distorted-wave Born approximation. (auth)

5972 COSMIC ABUNDANCES AND THE EXTRAPOLATION OF NUCLEAR SYSTEMATICS. Seeger, Philip A. (Los Alamos Scientific Lab., N. Mex.). pp 25-36 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.–299(Vol.1); CONF-680307–(Vol.1).

The semi-empirical atomic mass law is a well-known way of representing nuclear systematics near the valley of beta stability. The fine structure of the mass surface provides evidence of nuclear shell effects and deformations. In order to calculate the abundances of nuclides synthesized by rapid neutron capture (r-process) in astrophysical events, nuclear systematics must be extrapolated to the extreme neutron-rich area of the N,Z-plane, and the details of shell and deformation effects become paramount. A mass law with correction terms based on the Nilsson model is presented and shown to be adequate for simplified calculations of the r-process. Equilibrium nuclear deformations are also found. (auth)

5973 EFFECTIVE NUCLEAR POTENTIALS IN s-d SHELL. Dikshit, J. J. (M. G. Science Inst., Ahmedabad, India). Indian J. Phys., 42: 160-6(Mar. 1968).

The radial integrals, in terms of which the effective interaction in nuclear shell model has been parameterized, were calculated for various potentials; and these are compared with the values obtained by Cohen, Lawson and Pandya. The potentials include some free nucleon-nucleon potentials proposed earlier, which fit the scattering data well. (auth)

5974 EXPERIMENTAL ESTIMATE FOR THE LEFT-HAND-CUT CONTRIBUTIONS IN NUCLEON–NUCLEON SCATTERING. Furuichi, Susumu (Rikkyo Univ., Tokyo); Suemitsu, Hiroshi; Watari, Wataro; Yonezawa, Minoru. Progr. Theor. Phys. (Kyoto), 40: 523-37(Sept. 1968).

In order to obtain the experimental values of the left-hand-cut contributions in the partial-wave dispersion relation for nucleon-nucleon scattering, the right-hand-cut contributions were calculated from the experimental data following Kantor's procedure using the results of phase-shift analyses of nucleon-nucleon scattering in both elastic and inelastic regions. (auth)

5975 THE QUANTUM-MECHANICAL THREE-BODY PROBLEM. PART II. THE PHENOMENOLOGICAL THEORY OF THE THREE-BODY PROBLEM. Kisdi, D. (ATOMKI (At. Kut. Intez.) Kozlem., 10: 184-97(July 1968). (In Hungarian).

The three-particle model of direct reactions was derived on the basis of a system consisting of p, n, and A, where A designates a nucleus, p and n a proton and a neutron, respectively. The three-particle problem is solved on the basis of two-particle problems, neglecting the p–A interaction. The model developed allows 6 types of reactions, including elastic scattering, stripping, breakup, elastic scattering, pickup and breakup. An attempt was made to determine the cross sections of the processes involved using center-of-mass coordinates. In spite of the many simplifying assumptions, the model is able to account for the most general properties of the processes; it indicates that nucleus A and the two-body problem must be described more realistically. Even in its primitive stage,

the model is better than the optical approximation because it accounts for the basic principle of the processes involved, i.e., the neutron exchange. (TTT)

5976 ORDINARY AND HIGHER RANDOM PHASE APPROXIMATIONS IN THE LUTTINGER MODEL. Kupelian, Newton John. Waltham, Mass., Brandeis Univ., 1968. 129p.

Thesis.

The Luttinger model, an exactly solvable model for fermions interacting via general two-body forces, is used as a theoretical laboratory for testing a sequence of decoupling approximations commonly referred to as the random phase approximations (RPA), the most familiar of which is the lowest. The contention that the successively higher orders of RPA give a uniformly converging sequence of results for quantities such as the ground-state energy, the modes of excitation and their spectrum and the momentum-space distribution $\bar{n}_k$ of particles in the system ground state is investigated. It is found that the exact excitation modes and the corresponding spectrum, as well as the exact correlation energy, can be obtained in the lowest RPA. As is well known, however, the free-gas distribution persists in the lowest RPA. Furthermore, the next higher RPA gives a vanishing contribution to these quantities, and again leads to a free-gas distribution in the bulk limit. Moreover, these results are independent of both the nature of V and the coupling strength. If the extent of the ability of an approximation scheme to predict the detailed structure of $\bar{n}_k$ as a function of the coupling constant, however large, is chosen as a measure of its effectiveness, it is concluded that the first few orders of RPA are sensibly powerless. Rather, accepting that the extent to which the RPA predicts the excitation spectrum and correlation energy is the measure of its effectiveness, then the opposite is concluded. Nonetheless, to find a method of predicting alterations to $\bar{n}_k$, especially a disappearance of the discontinuity at the Fermi energy for sufficiently strong coupling, is a highly desirable enterprise. Thus far, it has not been possible to find a decoupling scheme which predicts a depletion of the Fermi sea, although one has been suggested for future trial. (Diss. Abstr.)

5977 ON THE APPLICATION OF GREEN FUNCTIONS TO THE DESCRIPTION OF PAIRING EFFECTS OF DEFORMED ATOMIC NUCLEI. Fischer, B. (Univ., Giessen, Ger.). Z. Phys., 217: 457-64(1968). (In German).

The theory of nuclear pairing correlations, recently developed by Migdal, introduces only one constant, which should be nearly the same for all nuclei. Thus Green's function method was compared with the well-known BCS theory. The constant was fitted and the problem was solved by numerical methods. It was found that the constant varies as $A^{-\frac{1}{3}}$. The individual magnitude of the pairing energy depends strongly on the single-particle level density which determines the value of the renormalized coupling constant of the pair interaction. This allows the reproduction of the deviations of the pairing energy from the curve $\delta_n = 11.2\, A^{-\frac{1}{3}}$. The results are independent from the choice of the cut-off level. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

5978 (APDA-CFE-23) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT, JUNE 1968. Costello, R. H. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). Oct. 1968. Contract AT(11-1)-865. 37p. Dep. CFSTI.

A description of the removal tools for the Zr segments and their methods of application are presented. Cooling system clean-up operations are described. Maintenance during June is described. (D.C.C.)

5979 PRESTRESSED CONCRETE CONTAINMENT BUILDING FOR THE GENTILLY NUCLEAR POWER STATION. Laforte, B.; Ziegler, A. J. J. Prestressed Concrete Inst., 12: No. 6, 14-19(1967).

The nuclear power plant, currently under construction in Quebec Province, has a prestressed concrete containment structure erected by slip forming techniques. The many criteria used in the design of this structure and the many problems met and overcome by careful design and advance planning are described. (auth)

5980 FEED CONDITIONS AT THE NOVO-VORONEZH NUCLEAR POWER STATION. Kot, A. A. Elektr. Sta., No. 39, 41-4(Aug. 1968). (In Russian).

The first unit at Novo-Voronezh nuclear power station consists of a 210 MW water-water reactor and three condensing AK-70 turbines. Water removal equipment is mounted behind the H.P. end-stage blades and the L.P. blades are built up with Stellite to prevent edge erosion. It is found that removal of O_2 from the make-up water in the first and second circuits and suppression of water radiolysis by H_2 formed by the partial decomposition of NH_3 or hydrazine hydrate makes for reliable operation. (auth)

5981 STABILITY OF P_1-DYNAMICAL EQUATIONS. Schwalm, D. (EURATOM, Ispra, Italy). Nukleonik, 11: 305-7(Oct. 1968).

The nonlinear stability behavior of a nuclear power reactor is investigated by the use of the P_1-kinetic equations containing linear power feedback. It is shown that the power equilibrium point is not asymptotically stable in the large. The exact region of stability is given together with some approximations to it. 16 references. (auth)

5982 CONSIDERATIONS ON THE CHOICE OF REACTOR TYPE FOR THE FIRST AUSTRIAN NUCLEAR POWER PLANT. Gilli, Paul Viktor. Elektrotech. Maschinenbau, 85: 197-209 (1968). (In German).

A computer evaluation of the various types of reactors is made from the standpoint of power production in Austria. Light water, heavy water, and gas cooled reactor parameters are tabulated; the characteristics of each type are discussed. Fuel element requirements for each type of reactor are tabulated. Capital costs and operations costs are considered in detail. 32 references. (M.L.S.)

5983 SIX YEARS OPERATING EXPERIENCE WITH THE WINDSCALE AGR. Barton, L. (United Kingdom Atomic Energy Authority, Windscale, Eng.). Atomwirtschaft, 13: 550-3(Nov. 1968). (In German).

General operating experience with the Windscale AGR since 1963 is summarized, and the usefulness of the information obtained to the development of commercial AGR plants is discussed. Included are general operating behavior of the reactor, performance of individual components, fuel rotation, safety aspects, and development of AGR fuel. (H.D.R.)

5984 EUROPEAN ATOMIC INDUSTRY AND ITS MARKET. III. HEAT EXCHANGER, PUMPS, AND VALVES FOR NUCLEAR ENERGY INSTALLATIONS. Daldrup, H.; Pantleon, M. (EURATOM, Brussels). Atomwirtschaft, 13: 544-7(Nov. 1968). (In German).

Principal data are listed for the steam equipment and primary circuits of European nuclear power plants. European firms which supply the various pumps, motors, and heat exchangers are tabulated. (H.D.R.)

5985 ACCIDENT PROTECTION PROCEDURES FOR GUNDREMMINGEN. IMPRESSIONS AND EXPERIENCE IN NUCLEAR POWER PLANT MANAGEMENT. Eickelpasch, N. (Kernkraftwerk RWE-Bayernwerk, GmbH, Gundremmingen, Ger.). Atomwirtschaft, 13: 555-8(Nov. 1968). (In German).

The training procedures and the essential checks on instrumentation and safety systems employed at the Gundremmingen power reactor are described.

5986 BALANCE OF NUCLEAR ENERGY DEVELOPMENT IN CANADA. Bruechner, H.-J. (Fachbereich Kernenergieanlagen, Frankfurt am Main). Atomwirtschaft, 13: 560-1(Nov. 1968). (In German).

The progress of nuclear energy development in Canada over the past 25 years is summarized from papers presented at the joint American Nuclear Society–Canadian Nuclear Association Conference from June 9 to 13, 1968, in Toronto. Capabilities of the Canadian nuclear industry in fuel element fabrication, construction of nuclear instruments and components, and construction of complete nuclear power plants are discussed. (H.D.R.)

5987 INVESTIGATIONS OF OSCILLATIONS OF THE CORE SUPPORT STRUCTURE OF THE KWO [OBRIGHEIM POWER REACTOR]. Knoedler, D.; Ruf, R. (Siemens AG, Erlangen, Ger.). Atomwirtschaft, 13: 535-43(Nov. 1968). (In German).

The calculations, test procedures, instrumentation, and results of an investigation of the vibration resistance of the fixed supports of the Obrigheim reactor core structure are presented. The thermal shielding, core structure, and instruments are described, and measurements are tabulated. The results produced, in part, changes in core construction; for example, the fasteners on the thermal shield were strengthened. It was also concluded that measurements previously considered for the Stade reactor core are, in fact, necessary. (H.D.R.)

5988 MEASUREMENT TECHNIQUES IN NUCLEAR PORTION OF THE LINGEN NUCLEAR POWER PLANT. Schruefer, Elmar. Tech. Mitt. AEG-Telefunken, 58: 377-83(1968). (In German).

In-core neutron flux measurement techniques are described for the Lingen Power Reactor. Measurement ranges of the instruments are shown graphically. Area monitoring and process instrumentation are discussed. Reactor pressure regulating instrumentation is discussed. Reactor protection systems are described. 11 references. (M.L.S.)

5989 APPLICATION OF A COMPUTERISED ALARM-ANALYSIS SYSTEM TO A NUCLEAR POWER STATION. Patterson, D. (Nuclear Power Group, Knutsford, Eng.). Proc. Inst. Elec. Eng. (London), 115: 1858-64(Dec. 1968).

The alarm analysis by digital-computer system which has been installed and which is now operating at Oldbury nuclear power station is described. This is the first such plant in which alarm information is presented to the operators by c.r.t. displays. It is also shown how the predicted alarm fault patterns, on which the analysis is based, were prepared for programming. Some details of operational experience are given and conclusions drawn. (auth)

5990 LEGAL ASPECTS OF PEACEFUL USE OF NUCLEAR ENERGY. Bischof, W. (Univ., Goettingen, Ger.). Atomwirtschaft, 13: 561(Nov. 1968). (In German).

Papers presented at the first training session of the International Atomic Energy Organization on legal aspects of atomic energy from April 16 to 26, 1968, in Wien are summarized. Included in the training session were lectures by experts from national and international organizations and the outline of a model law for civil legal liability for nuclear injuries. (H.D.R.)

5991 PRIMARY ENERGY BALANCE FOR THE FEDERAL REPUBLIC OF GERMANY: 1966 AND 1967. Atomwirtschaft, 13: 563(Nov. 1968). (In German).

Production, import, export, stockpiles, and consumption of fuels for energy needs in the Federal Republic of Germany are tabulated for the years 1966 and 1967. The installation and electric power generation totals for nuclear energy are tabulated for the years 1961 to 1967. (H.D.R.)

Power Reactor Development

5992 (BAW-1326) SODIUM PARAMETER STUDY CODE: NAPS. COMPUTER PROGRAM FOR PARAMETRIC STUDIES OF SODIUM-COOLED FAST BREEDER REACTOR PLANTS. Crane, R. A.; Mayer, A.; Cardwell, W. R.; Beers, S. C. Jr. (Babcock and Wilcox Co., Lynchburg, Va. Nuclear Power Generation Dept.). Apr. 1968. Contract 31-109-38-1998. 209p. Dep. CFSTI.

For Argonne National Lab., Ill.

The NAPS computer code (Sodium Parameter Study) has been written to aid in designing sodium-cooled fast reactors. Given

the basic independent design parameters, the code determines the core thermal and hydraulic characteristics, structural requirements, nuclear performance, and plant power generation costs. Included in the code are the results of several studies performed to determine fuel fabrication costs, steam plant performance, heat exchanger costs, and nuclear performance. Data from these studies and the design techniques developed from current sodium technology form the basis of the design model. This design tool has been used in optimizing several preliminary sodium designs, and the results have shown good agreement with those obtained in detailed analyses. NAPS is an especially effective tool for parametric studies of trends in performance and economics that result from perturbations of one parameter. (auth)

5993 (ORNL-4294) I. STEELMAKING IN AN INDUSTRIAL COMPLEX. II. ACETYLENE PRODUCTION FROM NAPHTHA BY ELECTRIC ARC AND BY PARTIAL COMBUSTION. Squires, A. M.; Lobo, W. E. (Oak Ridge National Lab., Tenn.). Nov. 1968. Contract W-7405-eng-26. 32p. Dep. CFSTI.

The effects of a nuclear-powered agro-industrial complex on current steelmaking and acetylene production are discussed. A review of recent history and present status of conventional steelmaking is presented. Projections over the next 10 to 20 years are described. The cost of producing acetylene (and ethylene) from naphtha by the hydrogen-arc plasma process is compared with partial oxidation of naphtha. (D.C.C.)

5994 IRRADIATION FACILITY WITH PRESSURIZED WATER AND BOILING WATER CIRCULATION (LOOP II) FOR THE MZFR KARLSRUHE. Repetzki, K. R. (Gutehoffnungshuette Sterkrade AG, Erlangen, Ger.); Knaab, H. Kerntechnik, 10: 539-46(Oct. 1968). (In German and English).

The versatility of the Multi-Purpose Research Reactor at Karlsruhe for fuel element development will be increased by a testing loop for the irradiation of experimental fuel pin bundles. The loop will be operated under pressurized water or under boiling water conditions, independently of the coolant conditions of the reactor. The design of the loop and the special features of some of its components are described. The possibilities for irradiation experiments are outlined. (auth)

5995 IRRADIATION FACILITY WITH HEAVY WATER CIRCULATION (LOOP I) AT THE MZFR KARLSRUHE. 2. CONCEPT OF THE IRRADIATION FACILITY. Bojarsky, E.; Reiser, H. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 10: 532-8(Oct. 1968). (In German and English).

The planned irradiation facility for fuel burn-up experiments will be coupled with the D_2O system of the MZFR. The fuel pins will be enclosed in capsules filled with Na or with NaK as the heat transfer medium. The cooling system will be capable of operating two irradiation rigs with 20 to 30 capsules each. It will be possible to operate the two rigs independently of each other with respect to D_2O temperatures and power output, up to about 2 MW. The design concepts are presented for the circulation system and for the irradiation rigs. A brief survey of safety considerations is presented, and the results of the studies carried out so far on the exchange and transport of irradiation rigs are described. (auth)

5996 IRRADIATION FACILITY WITH HEAVY WATER CIRCULATION (LOOP I) AT THE MZFR KARLSRUHE. 1. THE PROBLEM AND A PROPOSED SOLUTION. Gabolde, J. (EURATOM, Karlsruhe, Ger.). Kerntechnik, 10: 528-31(Oct. 1968). (In German and English).

The main problems arising in the irradiation of fuel pins for fast breeder reactors with thermal neutrons are discussed. For the special case of the MZFR reactor a solution is proposed entailing a pressurized heavy water loop and an in-pile rig containing several Na-filled capsules. The heavy water pressure in the loop is approximately equal to that in the reactor. The temperature of the fuel pin cans and the power output of the pins are kept constant in the course of irradiation by a controlled poisoning of the coolant with B. Calculations have shown that mixed oxide fuel pins with an initial enrichment of 8% Pu can be irradiated up to a relative burn-up in excess of 4%, under virtually constant power output and temperature conditions, without a negative effect on the reactivity of the reactor. (auth)

5997 IRRADIATION PROJECTS AT THE MULTI-PURPOSE RESEARCH REACTOR (MZFR). A GENERAL SURVEY. Tebbert, H.; Kraus, H.-J. (Gesellschaft fuer Kernforschung mbH, Leopoldshafen, Ger.). Kerntechnik, 10: 523-8(Oct. 1968). (In German and English).

In addition to the electric power generation, the multi-purpose research reactor MZFR is intended specifically as an irradiation source for advanced fuel elements for a wide variety of reactor types. Its high neutron flux density, and the availability of specialized experimental facilities in six cooling channels, offer particularly favorable possibilities in this context. Three experimental loops are to be implemented, namely, the Na capsule loop for the irradiation of fuel rods for Na-cooled fast breeder reactors (loop I), the combined boiling water and pressurized water loop for the irradiation of advanced fuel elements for these reactor types (loop II), and the superheated steam loop for the irradiation of fuel rods for the steam-cooled fast breeder reactor (loop III). In addition, a number of advanced fuel elements are to be irradiated in several normal positions in the reactor. (auth)

5998 300-MW THORIUM HIGH-TEMPERATURE REACTOR (THTR) READY FOR CONSTRUCTION. Status Report, Juelich, 3.-4.7.1968. Kliefoth, W. Kerntechnik, 10: 572-3(Oct. 1968). (In German).

A general description of the Thorium High Temperature Reactor is given. Operations parameters are tabulated. The advantages of the reactor and the pebble bed core are discussed. Physics characteristics of the system are listed. (M.L.S.)

5999 CONCEPT OF THE 300 MWe THORIUM HIGH TEMPERATURE REACTOR. Kirch, N. (KFA, Juelich, Ger.). Atomwirtschaft, 13: 562(Nov. 1968). (In German).

Papers from the THTR-Association conference in Jülich on July 3 and 4, 1968, are summarized. The objectives of the THTR power plant development are described, and the economic outlook for the pebble bed high temperature reactor is discussed. (H.D.R.)

6000 HOW SIGNIFICANT IS "NUCLEAR FALLOUT"? II. RESULTS OF INVESTIGATIONS ON THE USE OF NUCLEAR TECHNOLOGY IN TRADITIONAL FIELDS. Schabbeck, P. (Kienbaum Unternehmensberatung GmbH, Gummersbach, Ger.). Atomwirtschaft, 13: 558-9(Nov. 1968). (In German).

The second part of a series of three articles on applications of nuclear technology developments in non-nuclear fields is presented. The individual and total industrial aspects of nuclear technology applications are analyzed. (H.D.R.)

Kinetics and Dynamics

Refer also to abstracts 5779 and 5780.

6001 AN EXAMINATION OF METHODS FOR CALCULATING THE DOPPLER COEFFICIENT IN FAST BREEDER REACTORS. Dyos, M. W.; Adkins, C. R.; Murley, T. E. (Westinghouse Electric Corp., Madison, Pa.). pp 337-44 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

The importance of the Doppler coefficient of reactivity on fast breeder reactor safety dictates that it should be predicted with as much accuracy as possible. The approximations that are usually made in computing the Doppler coefficient are: the isolated narrow resonance approximation is used, interference scattering is neglected, overlap effects between different resonances and overlap between more than two sequences are neglected, heterogeneity is treated through an equivalence relation, and the unresolved resonances are assumed to be uniformly spaced in energy. The work reported here removes all of these restrictions. Furthermore, since the unresolved resonance region contributes significantly to the Doppler coefficient in fast reactors, this region is treated more rigorously through the generation of individual pseudo resonances using random sampling techniques within the framework of a single level Breit-Wigner formalism. A procedure is used which ensures that the pseudoresonance parameters yield resonance integrals that are consistent with broad group measured data. The resonance structure of each isotope is then complete over the energy range of interest for Doppler calculations. This resonance data is used in conjunction with an ultra fine group integral transport theory code. The validity of the usual approximate methods is examined by comparing with this more refined method of calculation. A numerical comparison is made for a plutonium-uranium carbide-fueled, sodium-cooled fast breeder reactor. (auth)

6002 RATIO OF PHOTON TO NEUTRON FISSION RATES IN FAST REACTORS. Dowdy, E. J.; Kohler, W. H.; Perry, R. T.; Poulsen, N. B. (Texas Agricultural and Mechanical Coll., College Station). pp 401-5 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

The large inventory of fuel in fast power reactors combined with the relatively low neutron fission cross sections have prompted this evaluation of the relative photofission to neutron

fission rates in such reactors. The photofission cross section of the fuel (especially ^{239}Pu) is relatively large and strongly energy dependent in the gamma-ray energy range of 6 to 10 MeV, a range in which there is a copious supply of gamma rays arising from fission and from neutron radiative capture in the reactor materials. The ratio of the photofission rate to neutron-induced fission rate in representative fast reactors was calculated. The multigroup neutron cross sections used in the computations were obtained from the set of Bondarenko, et al. and the group fluxes from AIM-6[2]. First flight gamma ray fluxes were used in computing the photofission reaction rates from the measured photofission excitation functions for the fuel materials, except for ^{241}Pu and ^{242}Pu for which no references for photofission are listed in CINDA. In every case, the ratio of photofission to neutron induced fission was calculated to be less than 1×10^{-3}. (auth)

6003 TRANSURANIUM CROSS SECTIONS WHICH INFLUENCE FBR ECONOMICS. Ottewitte, Eric H. (Atomics International, Canoga Park, Calif.). pp 415-25 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

Many of the cross-section uncertainties pertinent to FBR physics are well known: particularly σ_n, $\alpha(^{238}U)$, $\sigma_n, \alpha(^{240}Pu)$, $\alpha(^{239}Pu)$, and fission product absorptions. A quantitative evaluation of the effect on fuel cycle costs of FBR transuranium isotope production, specifically, isotopes ^{232}U through ^{244}Cm. The results show that many transuranium isotopes besides ^{238}U and ^{239}Pu through ^{242}Pu may influence the FBR economics. The modes by which this may occur are isotope sales (^{237}Np, Am, and ^{244}Cm), alpha-emitter radiological safety considerations in the design of reactor and reprocessing plants, gamma and neutron shielding requirements in fuel fabrication, alpha-radiation destruction of reprocessing solvent and ion-exchange media. Cross-section needs for these phenomena are assigned relative importance from the quantitative results. (auth)

6004 USE OF NEUTRON DATA IN THERMAL REACTOR POWER PLANT DESIGN. French, R. J. (Westinghouse Electric Corp., Pittsburgh). pp 259-72 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.1); CONF-680307-(Vol.1).

The areas in which an improvement in the accuracy of neutron data can be demonstrated to result in an improvement in the economic performance of a pressurized-water reactor core are examined. The factors that affect the economics of core performance are grouped in two parts: those which affect the power capability of the core, and those which affect the fuel performance in terms of burnup, fissile material depletion, and fertile material conversion. It is concluded that the factors which most significantly affect plant design are those which become important or change significantly at high burnup. (D.C.W.)

Control Systems

6005 METHOD AND APPARATUS FOR THE OUTPUT TEMPERATURE CONTROL OF A NUCLEAR REACTOR PLANT. Kaegi, J. (to Sulzer Brothers Ltd.). Canadian Patent 789,667. July 9, 1968. Priority date Oct. 30, 1963, Switzerland.

A gas cooled nuclear reactor is coupled to a vapour generator which in turn operates a turbine. A system of temperature detectors, valves, and by-pass lines regulate a blower and control rod mechanism so that the output temperature of the reactor coolant is under prompt control in response to the demands of the turbine. (F.S.A.)

Cooling Systems

6006 HETEROGENEOUS NUCLEAR REACTOR OF THE PRESSURE VESSEL TYPE. Braun, W.; Winkler, F. (to Siemens-Schuckertwerke Aktiengesellschaft). Canadian Patent 792,324. Aug. 13, 1968. Priority date Aug. 8, 1964, Germany.

The reactor is moderated and cooled by water and operated at supercritical temperature and pressure. The combined water moderator and coolant are maintained at the same pressure throughout the vessel. Important features described are regulating valves, countercurrent flow in the fuel and moderator tubes which are in a parallel grid within the core, primary and secondary coolant circuits with heat exchangers, a turbine in the secondary circuit, and a fluid neutron absorber for use in startup and shutdown with a separating device for its removal from the coolant as required. A mixing and collecting chamber is included at the ends of the fuel rods. This construction of the reactor core provides automatic control and stabilization of the entire reactor. (F.S.A.)

6007 HIGH-PRESSURE HEAT-TRANSFER TESTS ON BWR CORES. Fujisaki, Yukio; Kagawa, Tatsuo (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rebyu, 23: 1332-7(Oct. 1968). (In Japanese).

A high-pressure heat-transfer test loop was constructed to determine the maximum heat flux allowable in BWR core, and data on burn-out heat flux were recorded for 4-rod, 5-rod and annular-tube test sections. The ranges of variables investigated were as follows: pressure, 1.0 to 90 kg cm^2 abs.; mass velocity, 1.7×10^6 to 11.0×10^6 kg/m^2h; exit steam, 2 to 27%; and heat flux, 6.5×10^6 $kcal/m^2h$ or below. The heated lengths of the test sections were 300 to 450 mm; the outside diameter, both 10 mm. Investigation was also made on the method of increasing burn-out heat flux by using an orifice as a mixing promoter of two-phase flow. (NSA of Japan)

6008 TECHNOLOGY OF INTEGRATED PRIMARY CIRCUITS. Stueger, R. (Siemens AG, Erlangen, Ger.). Atomwirtschaft, 13: 547-8(Nov. 1968). (In German).

Included are summaries of papers presented at the ENEA-Symposium in Paris on the development of integrated primary circuits enclosed in prestressed concrete reactor vessels and on the development of gas turbines. (H.D.R.)

Fuels

Refer also to abstract 5084.

6009 (WCAP-3269-43) PERFORMANCE OF ZIRCALOY CLAD FUEL RODS IN SAXTON. McClintock, D. R. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). [nd]. Contract AT(30-1)-3269. 53p. Dep. CFSTI.

Six experimental assemblies containing Zircaloy-clad UO_2 fuel rods were irradiated as part of the Saxton reactor core to proof test materials and fabrication variables considered for use in a large plant chemical-shim environment. Detailed examinations were performed on selected fuel rods, including intentionally defected rods, representing peak burnups to 17,000 MWD/MTU and integrated fast flux exposure (>1 MeV) of 2×10^{21} nvt. Cladding dimensional changes, surface crud deposits, cladding corrosion, irradiation induced changes in cladding mechanical properties, and the effect of cladding defects were investigated. The results of these examinations revealed satisfactory performance in all cases. No effect of the borated environment or of in-pile exposure on the corrosion rate and associated hydrogen pickup of the Zircaloy cladding was determined. (auth)

6010 DEVICE AND METHOD FOR THE HEAT INSULATION OF REACTOR CHANNELS. Ohlmer, E.; Dufresne, J.; Finzi, S. (to EURATOM). Canadian Patent 792,323. Aug. 13, 1968. Priority date Mar. 16, 1964, Germany.

Clusters of fuel elements are surrounded by a fuel sheath through which the coolant flows. The sheath tubes are enclosed by a pressure tube with a clearance space between the sheath tube and the pressure tube to contain insulation so that the heavy water moderator will not exceed 90°C. The sheath tube has porous rings at intervals which restrict but do not prevent flow in the clearance space. Holes are bored in the sheath tube above each ring. The refrigerant liquid contains a dissolved gas which comes out of solution and collects in the clearance space between rings. This gas provides good insulation and also exerts an inward pressure on the sheath tube so that the latter may be thin and not absorb many neutrons. Pressures of coolant flow and refrigerant liquid containing the dissolved gas in the clearance space may be adjusted so that a good insulating effect is obtained. (F.S.A.)

6011 FAST NUCLEAR REACTOR FUEL ELEMENT INTERLOCKING ASSEMBLY. Schmidt, G. (to Gesellschaft fuer Kernforschung mbH). Canadian Patent 789,666. July 9, 1968. Priority date Aug. 17, 1963, Germany.

A fuel element assembly is described for use in a gas cooled, fast reactor where high velocity is desirable for rapid heat removal. Six fins on each element serve as spacers and interlocking devices. A single element has three fins with a series of hooks directed downward and three other fins with hooks pointing upward. Thus the hooks in three adjacent elements interlock firmly to form an approximately triangular channel for coolant flow. A large number of elements are assembled in a lattice in the reactor core. Slight axial movement of elements due to thermal stresses is possible but rotation of an element is impossible so that a firm lattice spacing is maintained. Vibration which might be caused by the high velocity of the coolant is avoided. (F.S.A.)

6012 POWER FROM THERMIONIC CONVERTERS. Bohdansky, J. (EURATOM–CCR, Ispra, Italy). Atomwirtschaft, 13: 548-9(Nov. 1968). (In German).

Papers presented at the International Conference on Production of Electrical Energy with Thermionic Converters, May 27 to 31, 1968, in Stresa are summarized. Converter fuel element development for ground-based reactors and heat pipe development for thermionic space reactors are emphasized. (H.D.R.)

Operation and Economics

6013 HOW PWR PERFORMANCE IS OPTIMIZED. Miller, D. L. Power, 112: No. 12, 51-4(Dec. 1968).

Optimization of pressurized-water reactor operation is discussed under the following topics: fuel cycling; chemical shimming; and advanced control concepts. (D.C.C.)

6014 FRESH WATER FROM NUCLEAR POWER. Bainbridge, G. R. Energ. Nucl. (Milan), 15: 794-9(Dec. 1968).

British work on flash distillation is discussed from the point of view of its economic advantage as a complement to the operation of advanced gas-cooled and steam-generating heavy-water moderated nuclear power plants. (auth)

Safety and Siting

6015 HEAVY WATER REACTOR. Hannerz, K. (to Allmanna Svenska Elektriska Aktiebolaget). Canadian Patent 791,242. July 30, 1968. Priority date Oct. 23, 1964, Sweden.

The reactor enclosed in a pressure vessel employs boiling heavy water as the working medium and a separate moderator tank within, which also uses heavy water. A rapid shutdown method is described which does not require a large dump tank. The moderator tank is connected to the steam chamber through a number of open tubes, the tops of which are above the heavy water level in the pressure vessel. A pressure regulating system with valves and a pump allows the energy of the condensing steam during a shutdown to be absorbed in heating the large moderator volume quite suddenly. Possible excess pressure is relieved by the rapid condensation of the steam. A small discharge tank is connected to the moderator tank. (F.S.A.)

6016 NUCLEAR POWER PLANT SAFETY. Gruemm, Hans Elektrotech. Maschinenbau, 85: 225-35(1968). (In German).

A concept of nuclear risk is presented; this is applied to nuclear energy as a whole, and particularly, to power reactors. Safety records are given for the nuclear industry for the 1944-1964 period; these records are compared with other industries. The danger potential of reactors is assessed. The basic principles of reactor safety are outlined. Some examples of reactor accidents are given; methods for prevention of each accident-type are considered. Various types of containment systems are described; these systems are illustrated. Safety philosophies are reviewed. 29 references. (M.L.S.)

6017 CALCULATION OF CONCENTRATION BEHAVIOR DURING CHEMICAL DECONTAMINATION OF A NUCLEAR REACTOR PLANT. Beal, S. K.; Henderson, D. R. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Appl., 5: 464-78(Dec. 1968).

A simple mathematical model effectively represents the behavior of the chemical concentration during decontamination of a nuclear reactor plant. Use of the model makes it relatively easy to keep the chemical concentration within the desired limits even though chemical analyses are not immediately available. (auth)

6018 THE I.C.R.P. CRITICAL GROUP CONCEPT IN RELATION TO THE WINDSCALE SEA DISCHARGES. Preston, A.; Jefferies, D. F. (Fisheries Radiobiological Lab., Lowestoft, Eng.). Health Phys., 16: 33-46(Jan. 1969).

The application of the recently recommended I.C.R.P. concept of a critical exposure group to the limiting radiation exposure pathway, arising as a result of the Windscale sea discharges, is discussed in the light of recent surveys of the supply of Porphyra seaweed for the laverbread industry of South Wales, and the production, distribution and consumption of the critical material laverbread. Factors leading to the reduction of exposure rates assessed on the basis of the radioactivity levels in the raw seaweed are evaluated, and suggestions for incorporating them in a critical group model for the Windscale situation are made. The radiation exposure to the critical organ (lower large intestine) is estimated for both children and the critical group of adults; children are shown to experience a lower dose. The critical group contains adults of both sexes and has a median rate of laverbread consumption of 160 g per day. Based on the conservative assumption that pure Cumberland derived laverbread is consumed, the application of the model leads to estimated doses of 0.4 to 0.7 rem/yr to the lower large intestine during the period 1962 to 1967. These doses may be compared with the I.C.R.P. recommended dose limit for members of the public of 1.5 rems/yr. (auth)

Research and Test Reactors

Refer also to abstracts 5781, 5782, 5793, 5798, and 5892.

6019 (BNWL–750) THERMAL-HYDRAULIC AND MECHANICAL ASPECTS OF FTR FUEL PIN SPACER DESIGN. Cohn, P. D.; Bennett, T. J.; Fischer, M. A.; (and others) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1968. Contract AT(45-1)-1830. 144p. Dep. CFSTI.

Detailed analytical and experimental data and current program status of the hydraulic, mechanical, and thermal aspects of the FTR fuel pin and spacer design are presented. The data deal primarily with the wire wrap spacers. A satisfactory grid system has not yet been proposed and therefore cannot be analyzed. The results of the analyses and tests show that the reference wire wrap spacer system for the FTR fuel subassemblies will perform reliably throughout the fuel lifetime. Development of a grid spacer system comparable in performance to the wire wrap can also be expected. Hydraulic and subsequent thermal analyses show temperature gradients caused by excess flow around the assembly perimeter to be severe but acceptable from a mechanical stress standpoint. Another major technical requirement, accommodation of fuel pin diametral growth, was demonstrated both by analytical and experimental data to be adequate for the wire wrap system. While extensive analysis and testing remain to be done, the thorough analysis and experiments completed show the present spacer system to be feasible. (auth)

6020 (BNWL–887) REACTOR PHYSICS DEPARTMENT TECHNICAL ACTIVITIES QUARTERLY REPORT, APRIL–JUNE 1968. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1968. Contract AT(45-1)-1830. 115p. Dep. CFSTI.

ALUMINUM ALLOYS AND SYSTEMS — Al – Pu, fuel criticality for, effects of lattice spacing on
CRITICALITY STUDIES — measurement of aluminum alloy–plutonium alloy rod, effects of lattice spacing on
— startup calculations for HTLTR, analysis of
— calculation of plutonium-240, effects of isotopic content on
HIGH-TEMPERATURE LATTICE TEST REACTOR — startup of, effects of core configuration on
MATERIALS TESTING REACTOR — core physics measurements for Phoenix-fueled, comparison of
PHYSICAL CONSTANTS TESTING REACTOR — physics measurements for plutonium oxide (PuO_2)–uranium oxide (UO_2)-fueled, analysis of
PLUTONIUM-240 — criticality calculation for, effects of isotopic content on
PLUTONIUM ALLOYS AND SYSTEMS — Al – Pu, fuel criticality for, effects of lattice spacing on
PLUTONIUM OXIDES PuO_2 — PuO_2 – UO_2, fuel element reactivity of, radiation effects of PRTR exposure on
— PuO_2 – UO_2, physics measurements for PCTR fuel assemblies of, analysis of
PLUTONIUM RECYCLE CRITICAL FACILITY — power profiles for Phoenix-fueled, measurement of
PLUTONIUM RECYCLE TEST REACTOR — fuel assembly reactivity worth in, radiation effects of 7300 MWd on
REACTIVITY — calculation of PRTR plutonium oxide (PuO_2)–uranium oxide (UO_2) fuel elements, radiation effects on
REACTOR CONTROL ELEMENTS — reactivity worth of PRTR, radiation effects of 7300 MWd on
REACTOR FUEL ELEMENTS — assemblies of PRTR, radiation effects of 7300 MWd on
— assemblies of PRTR plutonium oxide (PuO_2)–uranium oxide (UO_2), radiation effects on reactivity of
— assemblies of PCTR plutonium oxide (PuO_2)–uranium oxide (UO_2), physics measurements for

6021 (GEAP–5642) UO_2 IRRADIATION FOR ORNL. Final Report. Rowland, T. C. (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). June 1968. Contract W-7405-eng-26; Subcontract ORNL-2932. 54p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.
GENERAL ELECTRIC TEST REACTOR — fuel elements for, burnup performance of Zircaloy 2-clad uranium oxide (UO_2)
REACTOR FUEL ELEMENTS — fabrication of GETR Zircaloy 2-clad uranium oxide (UO_2), description of

—burnup of GETR Zircaloy 2-clad uranium oxide (UO_2), analysis of
URANIUM OXIDES UO_2—fuel element of, fabrication of Zircaloy 2-clad GETR
—fuel isotopic analysis of, effects of burnup on GETR
ZIRCALOY-2—cladding for GETR uranium oxide (UO_2) fuel elements, fabrication of
—radiation effects on mechanical properties of tubes fuel element cladding of, effects of GETR fuel burnup on (D.C.C.)

6022 (ORNL-RSIC-24) COMPILATION OF DATA ON EXPERIMENTAL SHIELDING FACILITIES AND TESTS OF SHIELDS OF OPERATING REACTORS. (European-American Committee on Reactor Physics. Oak Ridge National Lab., Tenn.). Nov. 1968. Contract W-7405-eng-26. 164p. (EACRP-U-37). Dep. CFSTI.

Data are presented on radiation shielding experimental facilities and reactor shield tests in European Nuclear Energy Agency countries, including Japan and the United States. These data were collected by means of questionnaires by the European American Committee on Reactor Physics and edited by the Radiation Shielding Information Center. Additional data on Soviet facilities are included. (auth)

6023 (ORNL-TM-2231) DESCRIPTION AND SAFETY ANALYSIS OF SIGNIFICANT CHANGE OF THE BULK SHIELDING REACTOR FOR 2-MW OPERATION. Stanford, L. E.; Hamrick, T. P.; Binford, F. T. (Oak Ridge National Lab., Tenn.). May 15, 1968. Contract W-7405-eng-26. 107p. Dep. CFSTI.

It is planned to revise the Bulk Shielding Reactor and its ancillary facilities to permit continuous operation at a power level of 2 MW. This requires the installation of a forced-convection cooling system containing a heat exchanger, cooling tower, decay tank, filter, and demineralizer units. Other revisions include increasing the worth of the control-rod complement and upgrading the containment system. The proposed operating conditions are well within the normal design range for reactors of this type and so impose no new problems. Analysis of the MCA indicates that maximum off-site radiation exposures would be far below the guideline values set forth in 10 CFR, Part 100. The changes are expected to be completed by about October, 1966. (auth)

6024 (ORNL-TM-2321) THE EFFECT OF FISSION PRODUCTS ON IGNITION OF IODIZED CHARCOAL (IN-PILE EXPERIMENT IGR-3). Shields, R. P.; Adams, R. E. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 23p. Dep. CFSTI.

An in-pile experiment has been performed in which the ignition behavior of MSA 85851, an I_2 impregnated (iodized) charcoal, was studied in the presence of fission products. After 4 hours of exposure to volatile fission products, this charcoal ignited at a temperature 35°C lower than it did in the laboratory: 327 vs 362°C. A second charcoal adsorber containing a 2-inch depth of MSA 85851 charcoal was exposed to determine the distribution of radioiodine in a charcoal mass; 73% was in the first 0.5 inch, 13% in the next 0.8 inch and 4% in the remaining 0.7 inch. Approximately 10% of the I_2 entering this adsorber passed through and was found in a second charcoal adsorber. (auth)

6025 (ORNL-TM-2325) EXPERIMENTAL INVESTIGATION OF HFIR FUEL PLATE DEFLECTIONS INDUCED BY TEMPERATURE AND PRESSURE DIFFERENTIALS. Cheverton, R. D.; Kelley, W. H. (Oak Ridge National Lab., Tenn.). Aug. 16, 1968. Contract W-7405-eng-26. 59p. Dep. CFSTI.

Fuel plate deflections in the High Flux Isotope Reactor fuel element have been investigated experimentally by subjecting a single plate to thermally induced displacements and to pressure differentials. Of particular interest were the plate's mechanical stability characteristics when subjected to longitudinal loading along the two edges of the plate, a condition that is encountered when a temperature difference exists between the fuel plate and side plate. The results of the experiments indicate that under HFIR operating conditions the fuel plates will always deflect toward the convex side of the involute over the central portion of the plate and toward the concave side close to the ends. A plate was also subjected to a differential strain almost three times as great and a temperature 200°F higher than expected in HFIR; the same deflection characteristics were observed. In neither case was there any indication that the plate had buckled longitudinally, that is, that the critical load had been achieved. Pressure deflections were found to be the same as predicted with calculations. (auth)

6026 (ORNL-TM-2418) BULK SHIELDING FACILITY. Quarterly report, July–September 1968. Tabor, W. H. (comp.) (Oak Ridge National Lab., Tenn.). Oct. 29, 1968. Contract W-7405-eng-26. 27p. Dep. CFSTI.

Operations in the BSR for July to September 1968 are described. Core loadings for the quarter are illustrated. Maintenance requirements are listed. Operations in the PCA for July to September 1968 are also described. Core loadings and maintenance requirements are presented. (D.C.C.)

6027 IRRADIATION DEVICE. Arragon, P. A. P.; Sequin, M.; Gentil, J. A. (to Commissariat a l'Energie Atomique). Canadian Patent 790,697. July 23, 1968. Priority date June 10, 1964, France.

A device is described which permits identical irradiation of several samples and accurate measurement of the radiation dose to which they are exposed. It consists of a rotary shaft one portion of which penetrates into the flux of a swimming pool reactor, and at least one support unit which is integral with the shaft. This shaft is provided with several recesses for accommodating irradiation cells and at least one cell for measuring neutron and γ irradiation dosages. These recesses are uniformly spaced along a circumference which is centered on the shaft. A thermocouple is also included in one of the recesses for measuring temperature. (F.S.A.)

6028 MEASUREMENTS OF THE EFFECTIVE RESONANCE INTEGRAL OF A UO_2 CLUSTER. Accinni, F. (Laboratori CISE, Milan); Fava, L.; Sangiust, V. Energ. Nucl. (Milan), 15: 767-72(Dec. 1968).

Effective resonance integral measurements are reported for a 19-rod UO_2 cluster and a UO_2 single rod. The results for the single rod are compared with the Hellstrand value and, for cluster, with PROCELLA code calculations. 13 references. (auth)

6029 δ^{28} MEASUREMENT IN UO_2–D_2O LATTICES. Accinni, F.; Tonolinin, F. (Laboratori CISE, Milan). Energ. Nucl. (Milan), 15: 805-6(Dec. 1968).

Fast fission ratio measurements are presented for CIRENE fuel elements in RB-1 reactor. The fuel assembly consists of a 19 rod cluster of UO_2 fuel elements. 4 references. (D.C.C.)

6030 DIFFERENTIAL DATA AND THE INTERPRETATION OF LARGE, FAST REACTOR, CRITICAL EXPERIMENTS. Davey, W. G. (Argonne National Lab., Idaho Falls, Idaho). pp 1211-41 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

The major problem areas in the analysis of fast critical experiments are outlined primarily from the viewpoint of the experimental reactor physicist. The problems of performing fast critical experiments are also discussed. The need for more accurate nuclear data is stressed. (D.C.W.)

6031 CALCULATIONS OF FAST CRITICAL EXPERIMENTS USING ENDF/B DATA AND A MODIFIED ENDF/B DATA FILE. Pitterle, T. A.; Page, E. M.; Yamamoto, M. (Atomic Power Development Associates, Inc., Detroit). Contract AT(11-1)-865. pp 1243-51 of Neutron Cross Sections and Technology. Goldman, D. T. (ed.). Washington, D. C., National Bureau of Standards, 1968.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C. See NBS-SPEC.PUBL.-299(Vol.2); CONF-680307-(Vol.2).

Calculations are presented for the ^{239}Pu-fueled ZPR-III Assembly 48 and the ^{235}U-fueled ZPR-VI Assembly 2 using two cross-section data files: the recently compiled ENDF/B data file and a modified ENDF/B data file. For the modified ENDF/B file, cross sections were re-evaluated as follows: capture and fission for ^{235}U, ^{238}U, ^{239}Pu, and ^{240}Pu; capture for Fe, Cr, Ni, Mo, and Na; inelastic scattering for ^{238}U and Cr; and elastic scattering for the 2.85-keV resonance in Na. Using the MC^2 code (Multigroup Constants Code), multigroup cross sections were calculated with each data file for the above-mentioned assemblies. One- and two-dimensional diffusion theory calculations were then compared with experiment for criticality, reaction rate ratios, material worths, and sodium void coefficients. (auth)

6032 THE DEMOKRITOS NUCLEAR RESEARCH CENTRE, Greece. Dimotakis, Paul N. (Atomic Energy Commission, Athens). Nature (London), 220: 561-2(Nov. 30, 1968).

An account is given of the establishment of an atomic research centre in Greece that has contributed substantially to the growth of scientific research. (auth)

Rocket and Space Reactors

Refer also to abstract 6012.

6033 REVIEW OF THE ALKALI METAL RANKINE TECHNOLOGY PROGRAM. Manson, S. V. (National Aeronautics and Space Administration, Washington, D. C.). J. Spacecraft Rockets, 5: 1249-59(Nov. 1968).

The status of the alkali metal Rankine program is described in three phases: basic technology, with particular regard to critical areas; component technology; and system technology. The powerplant being developed consists of four loops: a Li primary loop, a K power-conversion loop, a NaK heat-rejection loop, and a NaK auxiliary cooling loop. Topics discussed include: corrosion, creep bearings, rotor and bearing dynamics, seals, erosion, two-phase flow stability, pumps, boiler, turbine, alternator, turboalternator, and reactor. 84 references. (D.C.C.)

6034 NUCLEAR THERMIONIC SPACE POWER CONCEPT USING ROD CONTROL AND HEAT PIPES. Anderson, John L.; Lantz, Edward (Lewis Research Center, Cleveland). Nucl. Appl., 5: 424-36(Dec. 1968).

A nuclear reactor space power system using out-of-pile thermionic diodes, heat pipes, and a dual central absorber rod type of reactivity control was studied. Emphasis is placed on the neutronic aspects and general feasibility of the concept. Comparison is made between ^{233}UN and ^{235}UN and ^{239}PuN fuels. From a neutronic standpoint ^{239}PuN is found to be a slightly better fuel than ^{233}UN for this fast spectrum reactor. In this concept, heat is transferred from the reactor core to the thermionic diodes by layers of radial heat pipes stacked alternately with slabs of fuel. For this out-of-pile concept, which would supply about 130 kW(e), the reactor can be considerably smaller than the equivalent reactor with in-pile diodes. It would be particularly adaptable to a shadow-shielded type of application. (auth)

Marine and Portable Power Reactors

Refer also to abstract 5083.

6035 THE MEASURING AND CONTROL EQUIPMENT OF THE NUCLEAR SHIP "OTTO HAHN." Weidmann, Juergen. (Hartmann and Braun AG, Frankfurt am Main). VDI (Ver. Deut. Ing.) Z., 110: 1429-32(Nov. 1968). (In German).

Novel installations have been incorporated aboard this bulk carrier for the measuring, controlling, and supervising of many quantities of state. It was necessary to choose the equipment in such a manner that its operational efficiency remains undisturbed at all oscillatory frequencies, oscillatory amplitudes, and accelerations which occur on this ship even at a maximum inclination angle of ±45° and at a trimming angle of 12°, and which may also be caused by the rolling and pitching movements of the ship. (auth)

Reactor Theory

Refer also to abstracts 5751, 5752, 5757–5759, 5772, 5779–5781, 5799, 6003, and 6004.

6036 (KURRI-TR-33) TWO-DIMENSIONAL FOUR-GROUP CALCULATION BASED ON PARTIAL BUCKLING. Okamoto, Sunao (Kyoto Univ. (Japan). Research Reactor Inst.). [nd]. 74p. (In Japanese). Dep.

A new method is proposed to solve the multi-group diffusion equation. The neutron flux distribution is represented as a polynominal expression. This is useful because no change is required for its fundamental formation to accord with varying geometric factors such as shape of the section and buckling of the flux distribution. The method is applied successfully to a two-dimensional and four-group problem, where the concept of partial buckling is introduced to meet the boundary conditions calculated from the flux distribution of the system. In the appendix a brief description is made of the computer code for NEAC 2203 within the number of 4 energy groups and within the number of 10 regions. (NSA of Japan)

6037 DEVELOPMENT OF TRANSITION HEAT CRISIS WITH HIGH PRESSURE IN TUBES WITH AND WITHOUT VORTEX GENERATION. Baehr, A.; Herkenrath, H.; Moerk-Moerkenstein, P. (EURATOM, Ispra, Italy). Nukleonik, 11: 261-4(Oct. 1968). (In German).

Inner-wall temperatures and heat transfer coefficients for different length pressurized tubes are determined as a function of localized enthalpy and pressure. Inner-wall temperature dependence on turbulence is evaluated. Critical attenuation factors and two phase flow heat transfer coefficients are tabulated for tubes with and without vortex flow. (M.L.S.)

6038 COOLANT GAS MIXING AND PRESSURE LEAKAGE IN 19-ROD FUEL ELEMENT ASSEMBLIES. Pietralla, G. (Kernforschungsanlage, Juelich, Ger.); Presser, K. H.; Rauber, A.; Ritter, M. Nukleonik, 11: 265-70(Oct. 1968). (In German).

The experimental determination of coolant gas mixing and pressure drop in fuel bundles are discussed. Use of a high pressure gas circuit in the Julich research reactor is described. Heat balances were determined from temperature profiles which were obtained by heating the rods electrically. Turbulence is determined as a function of velocity; data are shown graphically. 12 references. (M.L.S.)

6039 STABILITY IN THE FIRST APPROXIMATION AND A CRITICAL CASE RELATING TO NUCLEAR REACTOR KINETICS EQUATIONS. Di Pasquantonio, F. (ENEL, Milan). Nukleonik, 11: 276-82(Oct. 1968).

The utility of the new LaSalle theory is illustrated by means of a critical case analysis. In this sense it is pointed out that when k_1 (the zero power reactivity) is zero the shut-down state is unstable if one considers the equilibrium, in the sense of Liapunov, in the whole phase space and is, instead, stable if one considers the equilibrium, in the sense of LaSalle, in the region where all solutions are, physically, always contained. Moreover, owing to the simplicity of the matrix of the first approximation of the mathematical model of a nuclear reactor characterized by N groups of delayed neutrons and M temperatures, two theorems on the asymptotic stability in the small are given by means of direct analysis of characteristic equation without using the Routh-Hurwitz criterion or other methods of linear analysis. (auth)

6040 EXTRAPOLATED ENDPOINT FOR ADJACENT HALF-SPACES. Leuthaeuser, K.-D. (Univ., Kiel). Atomkernenergie, 13: 385-6(Nov.-Dec. 1968). (In German).

The extrapolated endpoint for adjacent half-spaces is evaluated numerically. 4 references. (auth)

6041 APPLICATIONS TO NUCLEAR REACTOR KINETICS OF AN EXTENSION OF LIAPUNOV'S DIRECT METHOD TO FUNCTIONAL-DIFFERENTIAL EQUATIONS. Di Pasquantonio, F. (ENEL, Milan); Kappel, F. Energ. Nucl. (Milan), 15: 757-66(Dec. 1968).

The most general form of mathematical models relating to point reactor kinetics are made up of functional-differential equations. Akcasu and Dalfes have investigated the stability of one of these models by means of an "Analytical Method" which is shown to be incorrect. Similarly Gyftopoulos has given a stability criterion relating to a system of functional-differential equations, by means of an unappropriate application of the classical Liapunov direct method. In general, Liapunov's direct method, in its classical form, cannot be applied to functional differential equations. However, as is well known, this method has recently been extended both to nonautonomous or autonomous functional-differential equations. The criteria can be rigorously proved by means of the extension of Liapunov's direct method to autonomous functional-differential equations given recently by Hale. Moreover, relative to Gyftopoulos' criterion, a domain of asymptotic stability is given here, which is surely contained in the domain of attraction of the power equilibrium state, since Gyftopoulos provides no proof for the domain presented. Finally, for a simple case of linear feedback, a condition is stated which causes the linear approximation to be asymptotically stable only over a finite range of operating power levels. 17 references. (auth)

Experimental Applications

Refer also to abstracts 5749, 6030, and 6031.

6042 INVESTIGATION OF INELASTIC SCATTERING OF SLOW NEUTRONS BY MODERATORS. Glaeser, W. (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 11: 282-97(Oct. 1968). (In German).

The space-, energy-, and time-dependent transport equations are used to describe the neutron flux in reactor moderators. A simplified mathematical model based on a position- and time-dependent correlation function is developed. The experimental method used for investigation of the scattering law is described. An expression for multiple-scattering corrections is determined; correction factors for multiple-scattering in graphite and water are shown graphically. Total and differential cross sections for water, zirconium hydride, and graphite are given; other scattering law parameters are listed. 110 references. (M.L.S.)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 4521 and 5443.

6043 (ORNL-4327) MECHANICAL PROPERTIES OF ARTIFICIAL GRAPHITES. A Survey Report. Greenstreet, W. L. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 49p. Dep. CFSTI.

A review of published mechanical properties data for artificial graphites is given; high-temperature as well as room-temperature data are included. The intent is to provide a unified description of the complex mechanical behavior associated with these materials. A brief history on graphite and discussions of crystalline structure and of manufacturing methods are included. (auth)

6044 (ORNL-TM-2258) IRRADIATION BEHAVIOR OF CLADDING AND STRUCTURAL MATERIALS. Weir, J. R.; Stiegler, J. O.; Bloom, E. E. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 49p. (CONF-680419-4). Dep. CFSTI.

From American Nuclear Society National Topical Meeting, Cincinnati, Ohio.

The effects of irradiation on the mechanical and physical properties of materials to be used as cladding and structural components in fast reactors are of great interest to the reactor designer. The general aspects of the problem are discussed in terms of the observed changes in properties and microstructure and the possible mechanisms that might explain the observed effects. The discussion is concerned primarily with the austenitic stainless steels and with changes in mechanical properties which occur at test temperatures near the irradiation temperatures. For convenience the problem is divided into three ranges of irradiation temperature: low temperatures, $T < 0.40\ T_m$; intermediate temperatures, $0.40\ T_m < T < 0.55\ T_m$; and high temperatures, $T > 0.55\ T_m$. (T_m is the melting point on the absolute temperature scale.) On the basis of data presently available the damage appears to be significantly different for each temperature range. In the low-temperature range there is an increase in yield strength and reduction of work-hardening coefficient and uniform strain. These effects result primarily from the interaction of dislocations with irradiation-produced defects. At intermediate temperatures irradiation-produced changes in the precipitation process become important. In this same temperature range the formation of voids and dislocation loops after irradiation to high fast neutron fluences causes large increases in yield strength and large reductions in ductility parameters. At high-irradiation temperatures strength properties are not affected; however, ductility is severely reduced. These effects result from helium produced by various (n,α) reactions. (auth)

6045 FLEXIBLE SPACER. Tarasuk, W. R.; Bessey, P. E.; Scholfield, P. D. (to Atomic Energy of Canada, Ltd.). Canadian Patent 792,325. Aug. 13, 1968.

The construction and method of assembly of 19-element or 28-element fuel bundles is described. A flexible spider plate at each end is spot welded to each fuel element which consists of a Zircaloy tube containing the fuel pellets. The fuel elements are also joined in threes along their length with flexible spacers of Zircaloy wire. These spacers have various shapes and are either spot welded or continuously welded to the individual fuel sheaths. Such flexible members allow for small movement of the fuel elements with respect to each other under the thermal stresses during operation in the reactor. (F.S.A.)

6046 PREFERRED BOUNDARY BREEDING OF ^{239}Pu IN IRRADIATED UO_2 NUCLEAR FUELS. Hiller, S.; Czerny, M. (Siemens AG, Erlangen, Ger.). Nukleonik, 11: 257-9(Sept. 1968). (In German).

Metallographic determination of plutonium-239 distribution in fuel elements irradiated to 318 MWd/t V is discussed. Micrographs and autoradiographs of the irradiated fuel elements are shown. (M.L.S.)

6047 CORRECTION FACTOR FOR IN-REACTOR SINTERING OF FAST OXIDE FUELS. Stevens, E. G. (Battelle-Northwest, Richland, Wash.). Nucl. Appl., 5: 410-16(Dec. 1968).

An in-reactor sintering phenomenon in high temperature regions of oxide fuels results in the formation of a central void and a lowered peak temperature. A Sintering Correction Factor is derived in terms of a basic fuel property ($\int k dT$, where k is the thermal conductivity and T, temperature) to help optimize the maximum allowable linear heat rate in fast reactor fuel pin design. (auth)

GENERAL

6048 (LA-3656) THEORETICAL SMALL-PARTICLE STATISTICS: A SUMMARY OF TECHNIQUES FOR DATA ANALYSIS WITH RECENT DEVELOPMENTS IN DATA COMPARISON, NOTATION, AND MIXTURE THEORY. Lewis, H. D.; Goldman, A. (Los Alamos Scientific Lab., N. Mex.). Jan. 1967. Contract W-7405-eng-36. 54p. Dep. CFSTI.

A rigorous development of methods for particle size data analysis based upon the form of the data generated by the various methods available for measurement of particle size distributions is presented. Data are classified into two general types, and methods for computing and comparing sample statistics are developed on the basis of Type I and II classifications for both the functional and nonfunctional representations of the sample data. An attempt is made to demonstrate the compatibility of recognized statistical notation and definition with the problem of particle size data analysis. A general theory and required notation is developed for description of mixtures of particulate systems, with emphasis on the practical relationship between mixtures proportioned by component weight, frequency or numbers of component particles, and Type I and II data forms. Application of the general theory for mixtures in the study of packing behavior of particulate systems is discussed. Formulae for computing and comparing sample statistics generated by the various particle size measurement methods are summarized in tables for both single-component systems and mixtures. (auth)

6049 (LA-4004) THE LAPLACE FORTRAN CODE. Hayes, John Knox (Los Alamos Scientific Lab., N. Mex.). Sept. 9, 1968. Contract W-7405-eng-36. 20p. Dep. CFSTI.

The subroutine LAPLACE used to obtain a numerical approximation to a solution of Laplace's equation is described. LAPLACE is written in FORTRAN for the CDC 6600. (W.H.K.)

6050 (ORNL-4325) COMPARISON OF SEVERAL DIFFERENT MODELS FOR FITTING DATA ON THE SOLUBILITY OF SILVER SULFATE IN AQUEOUS SOLUTIONS CONTAINING VARIOUS SUPPORTING ELECTROLYTES. Lietzke, M. H.; Stoughton, R. W. (Oak Ridge National Lab., Tenn.). Oct. 1968. Contract W-7405-eng-26. 21p. Dep. CFSTI.

Five different mathematical models for fitting solubility data were compared using data on the solubility of silver sulfate in aqueous solutions containing various supporting electrolytes. While all the models fit the data reasonably well, it is difficult to say whether any one of them fits the data better than the others. The possible existence of the $AgSO_4^-$ complex ion in solution is also discussed. (auth)